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LEFFEL'S DOUBLE TURBINE WATER WHEEL

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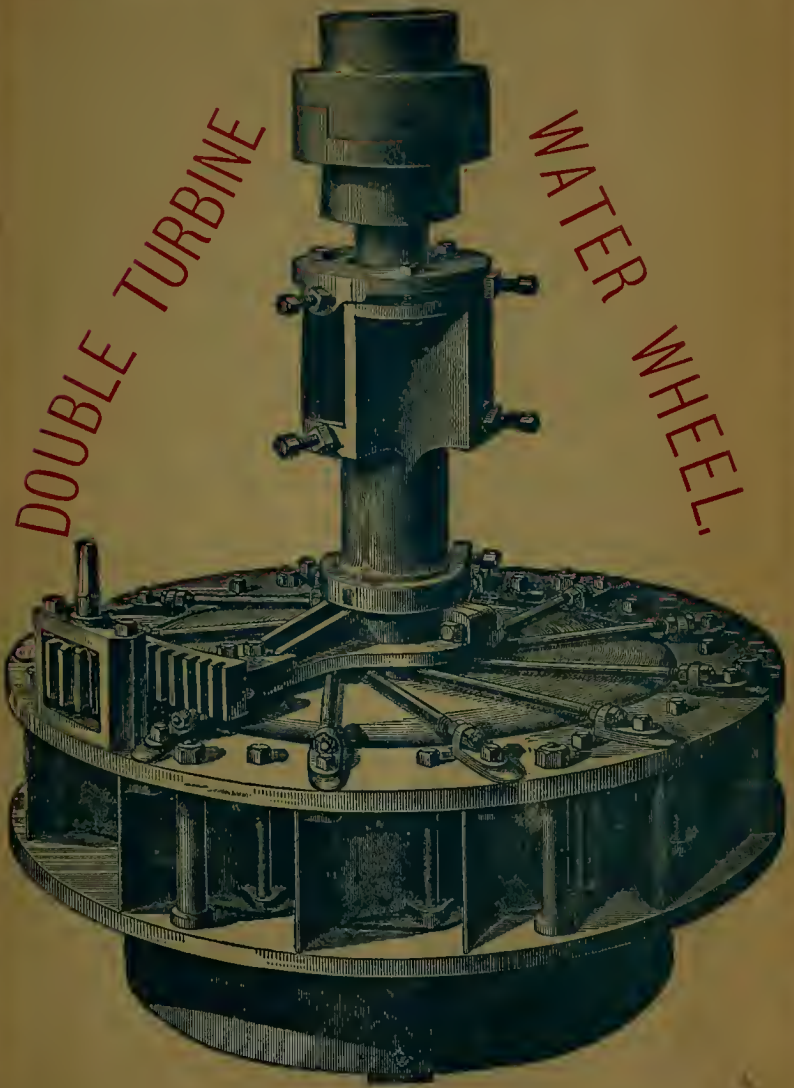
JEFFEL'S IMPROVED

DOUBLE TURBINE WATER WHEEL.



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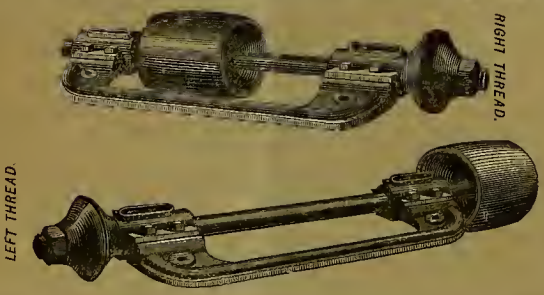

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ILLUSTRATED

DESCRIPTIVE PAMPHLET

-OF-

LEFFEL'S

Double Turbine Water Wheel.

MANUFACTURED BY

A. MYERS,

SAN FRANCISCO, CALIFORNIA.

PERSONS ABOUT BUILDING, OR REPAIRING MILLS

Of any description, should not fail to send to us for information. Our extensive and practical knowledge and experience with every variety of mill-work, millwrighting and machinery in connection with the introduction and manufacture of our Water Wheel; there being

10,000 WHEELS IN SUCCESSFUL OPERATION;

Gives us an Experience Rarely to be Found.

We have every advantage for supplying information concerning plans, specifications and estimates for Flour, Saw, Paper, Woolen, Cotton and Quartz Mills, of every description.

Address, A. MYERS, - - - 825 Capp Street,

P. O. Box 2293, San Francisco, Cal.

PREFACE.

In presenting this catalogue, we take great pleasnre in stating that our Wheel still holds the regal sway it has since *it was first introduced*, and it has proven itself to he the CHAMPION OF THE WORLD.

It must be admitted, that with our long experience with water powers, nearly 20 years, all those features which, under the various circnmstances arise, mnst necessarily present themselves to us, and we have invariahly taken advantage of these, to so improve our wheel that it will as nearly as possible meet every requirement.

As the publication of this pamphlet is not confined solely to the purpose of an advertisement, but for the purpose of giving, in a condensed form, a few plain rules, which have best obtained in the practice of mechanics and hydraulics, we have endeavored in this edition of our illustrated pamphlet, so far as experienoe has directed, to condonse and tahulate the various kinds of matter contained therein in such manner as to enable the reader to find that matter relating to the particular information desired.

In this pamphlet we do not pretend to give the reasone and explain theoretically why our wheel excels so greatly any known wheel; if we did, but few would understand its theoretical advantages. We deem it sufficient to give a description of the wheel, its size, shape, and many advantages, relyiug entirely upon the reputation it has made for itself, and the inquiries of those interested in water power, which we hope they will make of those who *know* its great superiority by a practical experience in the use of our wheels; that is we do not expect people to purchase onr wheel on account of its *theoretical* superiority, or from onr representations, but for its *actual* superiority, as demonstrated by the evidence of practical business men who have our wheels in actual use, and have tested them alongside of other wheels; and this evidence we wish you to procure for yourselves.

We present herewith a new edition of our wheel book, the necessity for it having heen created by the large call upon ns for our former edition, by the continued demand for onr Water Wheel and the flattering commendations we are daily receiving. We are continually confronting, in its introduction, circumstances of new and greater magnitude and difficnlty, with the uniform resnlt of practically demonstrating its adaptation to every emergency. Here arises, also, the demand for new methods of attaching the wheel to its work, and new means of communicating its power to the intended purpose. With over 10,000 Leffel Wheels now in use, there is left scarcely a conceivable species of machinery that is susceptihle of utilizing water as a motor, which is not driven by this pre-eminently, the Standard Wheel. Fifteen years has proven its durability and practical adaptation to every purpose. The wheel being used in so many mills, and giving universal satisfaction, is one of the greatest proofs of its merits and superiority. The enormous nnmber of our wheels used, the nnanimons praise accorded them, should be snfficient evidence that a party is trying no experiment, in putting in a Leffel Wheel.

The arrangement of this hook differs somewhat from our former editions; the new matter is, as usual, entirely original; having for its basis our large practice and experience. In the first part of the hook will he found illustrations, descriptions, tables and various appropriate articles; the descriptions of cuts being short, the engraving being designed in itself to clearly indicate the connection and arrangement of every part.

We have, in this edition, entirely omitted the liet of the thousands of onr wheels in nse all over the world; being confident that the general reputation of the wheel does not need this illnstration. The Leffel Wheel has become a household word in every camp and corner of onr land, and is favorahly known by all eminent mechanics throughout the world.

It is a fact worthy of special mention, that the parties nsing our wheels speak in high terms of praise, and often claim more for them than we do onrselves. While we are sincerely obliged to so many of our customers for so free an expression of their honest convictions, we are confident that the wheel fully merits their encomiums; and it is upon this, the universal verdict, we estahlish its claims to superiority; and beg your careful examination of the following pages.

The reputation of onr wheels having been so thoronghly established, we do not deem it essential with this issne to publish any certificates of merit, of which we have thousands, many of them having been sent ns entirely nnsolicited; bnt we believe that the universal knowledge of the Leffel Wheel throughont the world does not now need this display. We therefore present it on its merits.

A. MYERS.

San Francisco, March 1, 1879.

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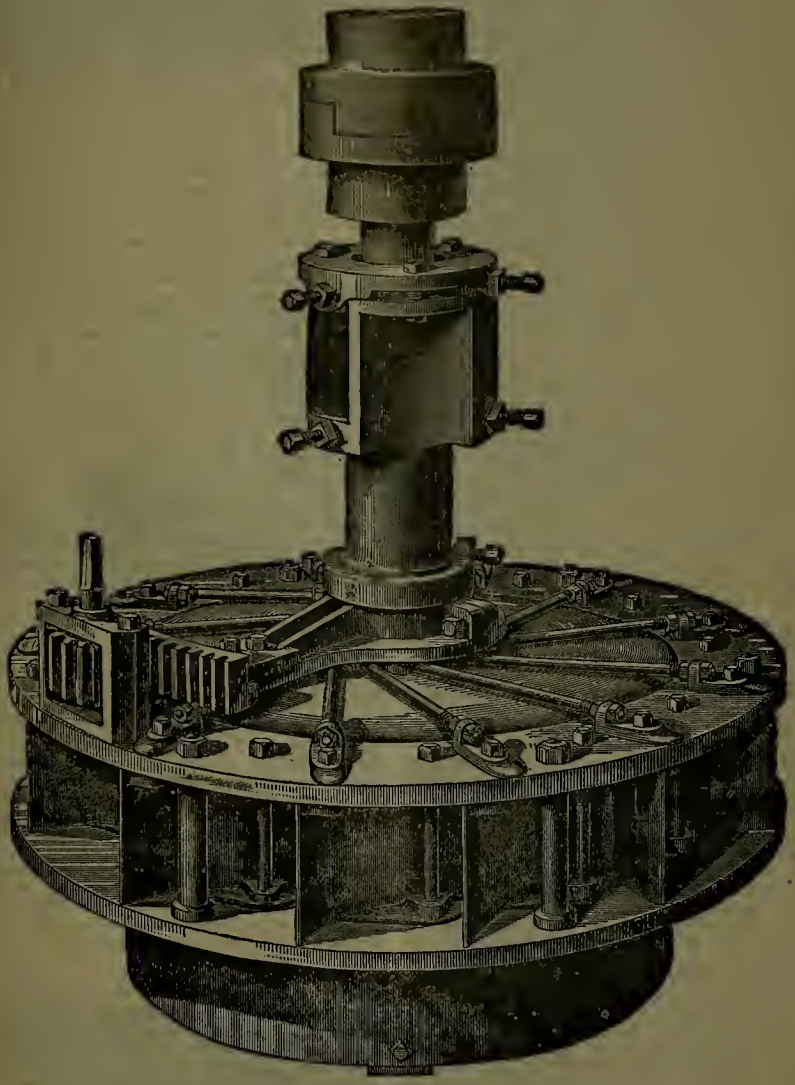
LEFFEL'S IMPROVED

Fig. 1.



Double Turbine Water Wheel.

Leffel's Improved Double Turbine Water Wheel.

There is, perhaps, no surer evidence of practical merit than success long estahlished and widely extended, and based upon repeated practical trials under the most exacting conditions. An invention of but little real ntility may ohtain a temporary reputation hy means of sbrewd management in bringing it before the puhlic, hut its deficiencies will inevitably come to light, and a final verdict will be pronounced npon it in accordance with the facts. Cases in point are of almost daily occurrence in which a transient popnlarity is gained hy a device wbich will not bear a test of experience, and wbich speedily disappears from the market. It is therefore hardly too much to say that the fact that *ten thousand* of the Leffel Turbine Water Wheels are now in successful operation, nnder heads varying from 1½ to 500 feet, and that the demand for them still continues, constitutes the strongest possible evidence that it is what it claimed to he hy its inventor and manufactnrers—the most perfect water wheel ever offered for sale.

Hardly less significant than the widespread celehrity of the Leffel Wheel is the fact, which has now hecome almost proverhial, that it is adopted hy huilders of other wheels as a standard of comparison. Directly or indirectly—whether by persistent disparagement of the Leffel Wheel, or confident assertions of their own equality to it—they are constantly giving their testimony to its superior merits. Formerly the overshot wheel was the standard hy which the relative excellence of other wheels was determined, hut of late years it has heen displaced in that position hy the Leffel Turhine. It is a common occnrrence for a rival manufacturer to urge that his wheel is at least "equal in point of economy to the Leffel Wheel;" and the same trihnte to its superiority is paid in a different, hut less striking, form hy other competitors, who devote their efforts solely to creating prejudice against the Leffel Wheel. Not content with this, they have, in many instances, imitated snch featnres of the wheel as are within their reach, appropriated the form and method of tahulating sizes, power, &c., originated hy James Leffel, modifying them in some trifling particulars to suit their pnrpose, and, without regard to the applicability of the tahles to tbeir wheels, have used them to show an apparent increase of power over the Leffel Wheel, when in fact they fall materially below it. Still another artifice of like natnre is that of getting possession privately of an old Leffel Wheel which has done service for eight or ten years, and may in the first place have heen nnskillfully put in, and snhjecting it to a private test with one of their own, in the presence of a few witnesses. In due time a victory over the Leffel Wheel is annonnced, with a flourisb of trumpets hefitting such a hrilliant achievement. Sooner or later the truth is very apt to come out, and it is very douhtful whetber the temporary profits of the fraud are not more than halanced by the damaging effect of the exposure.

How the Wheel has been Brought to Perfection.

No machine, however simple, durahle and perfect in appearance, will in every respect prove satisfactory when first put in operation. Many parts will require, perhaps a change of form, strengthening, or may he an entirely different arrangement upon application to the work to he performed, and a trial of two or three years. In fact, it requires years of diligent study and practical experience, particnlarly with a water wheel, to so perfect all of its parts as to make it successfnl under all circumstances, even thongh it he sound and practical in principle. Of conrse, many of them never can, hy any amonnt of lahor or attempted improvement, he made to operate all species of machinery, and must always remain hut little hetter than worthless. To the general principle first stated the Leffel Douhle Turhine has perhaps heen no exception. During its introduction for the first four or five years, many of them were, no douht, imperfect and not so durahly made, as all newly introduced machinery is necessarily. Yet it has heen onr constant aim and design to study and know its faults, which so large an experience wonld enahle us to discover, and to the proper remedies and improvements we have directed our attention, with the most gratifying results. A numher of parts have heen strengthened, others changed, and some added, all of which we conld point ont and describe, stating the object, pnrpose, etc., if we thought desirahle. Among the most notahle modifications and additions made (some of which are patented) are the process for lining the iron plates with hrass or any anticorrosive metal (applied only when especially ordered); the combination of the toothed segment with the gate-arm in such a manner that the segment can he removed when the teeth become worn; and a new one snpplied; the spherical and

HORIZONTAL PENSTOOK;

the use of steel gates or guides for some sizes, instead of iron; and the improved method of casting solidly in one piece hoth wheels, hy means of which the edge of the diaphragm can he made mnch thinner and yet stronger, assisting also to separate more perfectly the due proportion of water to each wheel. Half the huckets heing made of good hoiler iron, and the fillets retaining them heing improved, hoth in form and strength, it is impossible to hreak or tear ont any of them; as a result of which, out of the last 8,000 wheels put in operation, not one has lost a single hucket. One set of huckets could easily he holted or riveted to the wheel flange, if it were considered advisahle. All such holted buckets, on whatever kind of wheel they may he nsed, are, however, liahle to freqnent derangement by working loose and striking the inside or casing and end of guides often dropping entirely loose and hreaking others; snhjecting the parties to the expense and inconvenience of taking the wheel from the casing to

[*See page* 8.]

Fig. 2.

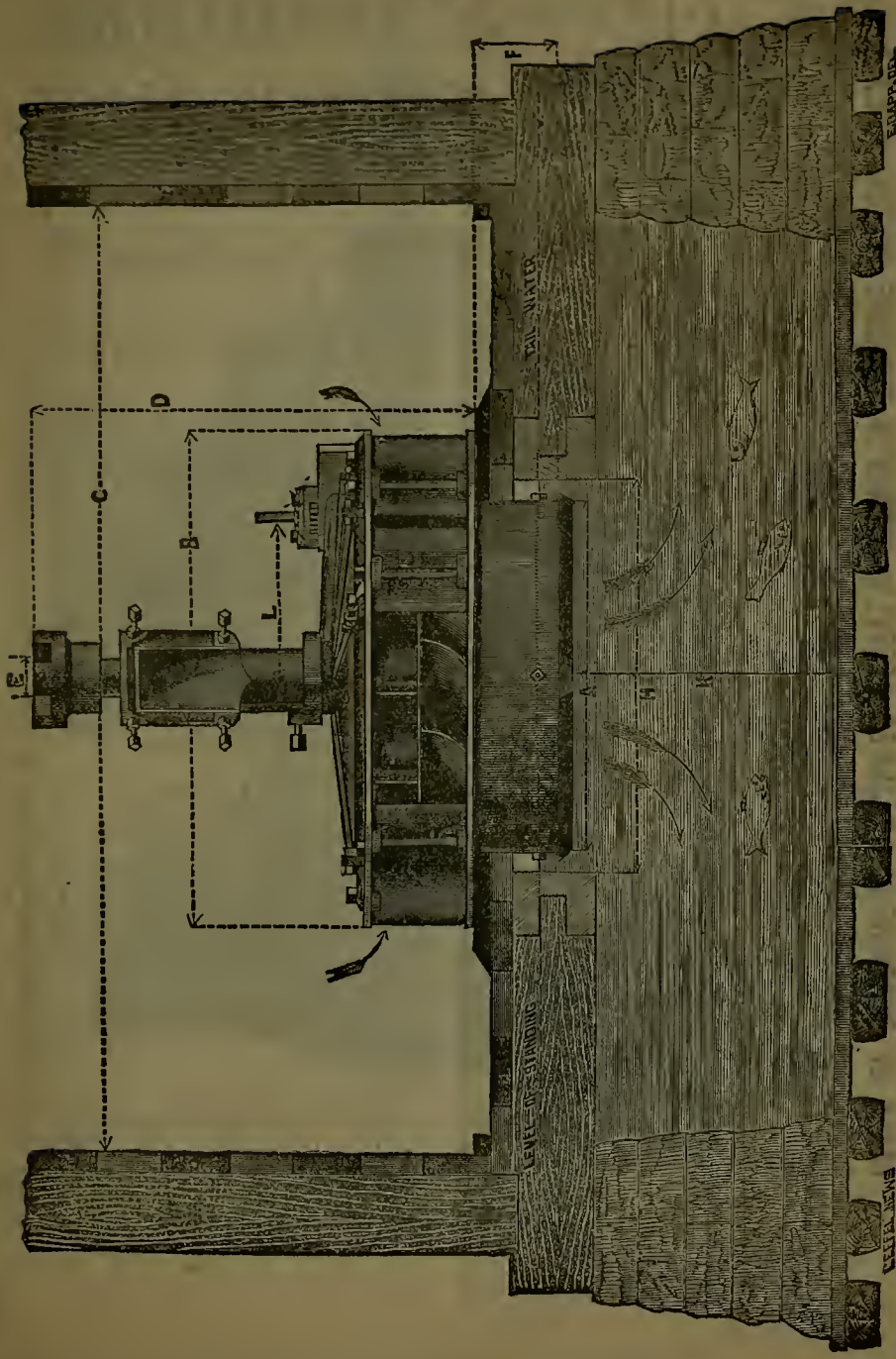


TABLE OF DIMENSIONS OF JAMES LEFFEL'S IMPROVED TURBINE WATER WHEELS.

(The Lettered Columns in Table Correspond with the Dotted Lines in Cut on Opposite Page.)

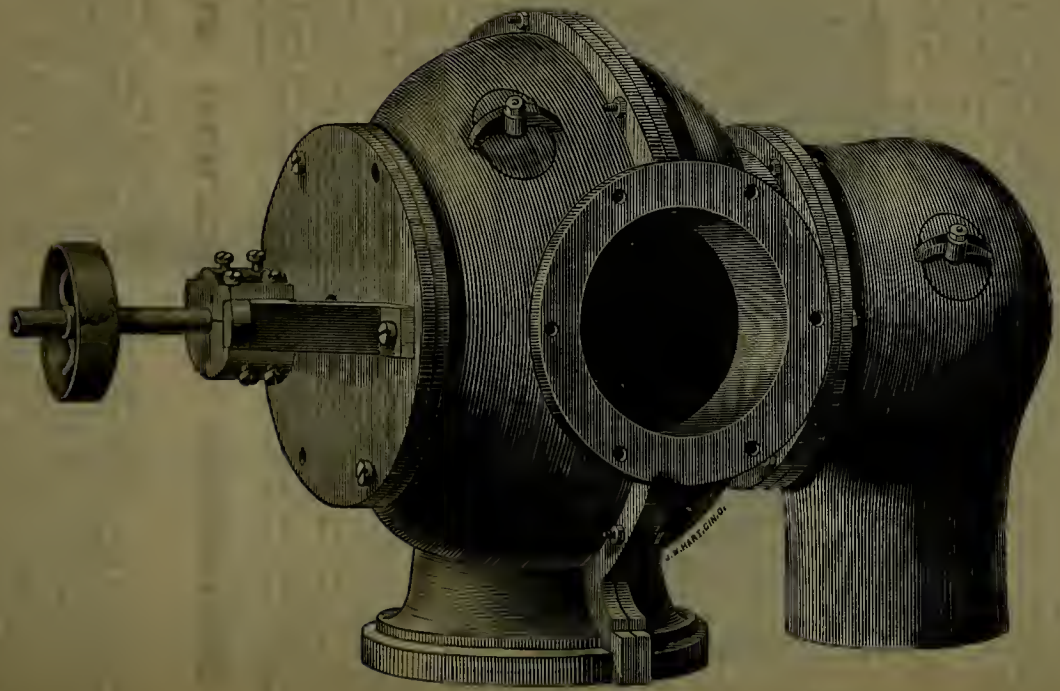
	A	B	C	D	E	F	K	H	L	M	
SIZE OF WHEELS	Diameter of Cylinder passing thro' floor of Flume	Diameter of Entire Casting	Internal Diameter of Flume.	Length of Shaft from Flange on floor of flume to Center of Coupling.	Diameter of Bore in upper half of Coupling.	Length of Cylinder passing thro' floor of flume.	Depth of pit from end of Cylinder to bottom of Pit.	Diameter of hole in the bottom of Flume for Wheel.	Distance from center of Gate rod to center of Wheel Shaft.	Cross Section of Entrance for water to Penstock.	WEIGHT OF WHEELS.
10	11⅛	14⅓	30 to 38	16¼	1⅛	2¾	20 to 23	12	6⅓	24 by 38	135
11⅓	12⅝	16½	32 to 40	17¼	1⅛	3	20 to 23	13⅓	7¼	26 by 40	155
13¼	15	19¼	35 to 43	18¼	1⅜	3¼	21 to 24	15¾	8⅓	28 by 43	175
15¼	16½	22	38 to 46	21¾	1⅞	3⅝	21 to 24	17¼	10⅓	30 by 40	240
17⅓	19	24¾	42 to 50	24	2	4⅝	22 to 25	20	11¾	33 by 50	300
20	21⅓	28	46 to 54	27¼	2⅛	4¾	22 to 25	22⅓	13¼	35 by 54	490
23	25¼	33	50 to 59	34¼	2⅝	5⅓	23 to 27	25⅓	15¼	38 by 59	866
26⅓	28⅓	38¼	54 to 65	37⅛	2⅞	7	24 to 28	30	16¾	42 by 65	1,142
30⅓	32¼	43⅓	65 to 72	38½	3⅛	7	25 to 30	33⅛	19¼	46 by 72	1,500
35	37¼	50	72 to 79	44⅜	4⅜	7⅝	27 to 32	38⅓	22⅓	50 by 79	2,380
40	42¼	56⅓	79 to 90	46¼	4⅜	9⅛	29 to 34	43⅓	25⅓	54 by 90	3,250
44	47	60	90 to 99	50½	4⅜	9⅞	31 to 37	48¼	27⅓	56 by 96	3,800
48	50¼	67	99 to 108	57⅓	5⅜	11¾	33 to 40	51¼	30⅓	60 by 108	4,680
52	54⅓	72	108 to 118	60	5⅜	11⅓	35 to 44	55⅓	32¾	63 by 118	5,280
56	60⅓	80⅓	118 to 128	68	5⅞	12⅓	37 to 48	61¼	36	66 by 128	7,500
61	63⅓	85	128 to 140	68	5⅞	8⅓	40 to 54	64¼	37⅓	68 by 140	10,000
66	69	89	137 to 152	70	5⅞	8	43 to 58	69⅓	40⅓	70 by 152	12,000
74	80½	102⅓	150 to 166	75	6	9	47 to 64	81	46	71 by 166	15,000
84	92⅓	112⅓	165 to 183	82	6⅓	9	52 to 72	93⅓	52¼	72 by 183	18,000
96	103⅓	124	180 to 200	88	7	10	60 to 84	105	57¾	72 by 200	20,000

NOTICE.—All the measurements in the above table are made in inches, and fractions of an inch.

MYERS' HORIZONTAL FLUME.

PATENTED APRIL 1ST, 1873.

Fig. 3.



The New Method.

[*Continued from page* 4.]
replace the broken ones. We prefer and recommend only those cast solidly into the Leffel Wheel, thns enabling them to withstand the shock of blocks, stones, and other rubbish to which they are so often snbjected, and avoiding also the annoyance of removing the wheel from casiug. Practically the wheel is perfect. In fact, the durability of the entire wheel and casing is snch that the entire amount of repairs called for per annum, is covered by a sum so extremely small as to be scarcely worth estimate. We have within the last four years so arranged and systematized the process of manufacture that if any part is accidently broken it can at once be duplicated, another being supplied by express on receipt of the necessary information. In short, the Leffel Improved Double Turbine has kept pace, from its first introduction, with the most advanced developments of mechanical science, and for any purpose for which the power of water is employed it may be safely guaranteed as having no equal in utility, economy, and durability.

MYERS' HORIZONTAL PENSTOCK.

Myers' Horizontal Penstock is now the most generally used for all mills and machine-shops of every description, as it does away with all use of bevel-gear, noise and racket. It has proven itself of great ntility and dnrability, and hence is universally favorably spoken of by all using it. Great expense and auuoyance is saved in its use.

The utility of this new method of attaching the wheel to all mills where a horizontal shaft is used, as the main shaft in the mill, will be apparent at first glance. The wheel is placed on a horizontal shaft, while it rnns vertically. The water is discharged through a peculiarly constructed draft-tnbe, and the lower end of the shaft has both a step and journal lubricated with water by a patented devise. This method of nsing tnrbine wheels was patented by myself, April 1, 1873, and since then has come into general use. About nine-tenths of all the wheels I have sold since, have employed this principle. I have mills driven in this manuer using Leffel Wheels, under heads varying from 10 to 400 feet fall, all giving general satisfaction. With this method we belt directly from the water-wheel shaft to the main shaft of the mill. With a high head and a small quantity of water, the attachment is direct, as a small pulley is used ou the wheel-shaft running upon a large pulley on the maiu shaft. Some of the mills now using this method are the Eureka Quartz Mill, on the Carson River, near Empire City, Nevada. This mill employs a 52-inch wheel under 38 feet fall, and drives 64 stamps, and all necessary machinery for a silver mill. The wheel yields over 400 horse-power, and has never been out of order since it was started in 1872, and to-day is giving the same satisfaction it did when it was first started.

Another is nsed at or near Trnckee, on Boca Creek, by the Nevada & Cahfornia Lumber Company—a 15-inch wheel, under 125 feet fall, developing 150 horse-power, and has frequently cut 125,000 feet of lnmber in 24 hours. This wheel has been in use five years, and is greatly praised. Its owners, Lonkey & Smith, have frequently said that a mill of its capacity and power conld not be constructed with engines and boilers for less than ten times the cost of this mill. And then, besides, there is no danger of fire; no engiueer is called up an honr or two before the mill is to start, to get up steam; but at any instant the power is ready to be applied, and is as easily governed as auy engine. The application of the power is as iustantaneous as lightning, yet perfectly controllable.

There are numerous shops and factories in various parts of the country now using the horizontal flume under low heads whose owners are equally as enthusiastic for its use as those usiug high heads. One of the great advantages all claim for it is the displaciug the cumbrous bevel and mitre gear heretofore used, which was always wearing out and frequently breaking—this causing great expense and loss of time, until new could be substituted—often thus causiug the loss of thousands of dollars by the stoppage of the quartz mill when the power was most needed. But by this plan we have never known or heard of an accident. We are confident, when this method is fully nnderstood, it will become nniversal. There is a decided advantage in using water in this way; every inch of the fall is ntilized, and the spouting velocity of the water is perfectly uniform in every part of the wheel. The spouting velocity is experienced where the greatest impingement of the water is, and that point is through the buckets, when the wheel is in motion. By the proper construction of the draft-tube, each column of water draws or presses on its appropriate atom or colnmn, thus producing perfectly uniform pressure on every part of the wheel at the same time.

This case or peustock is so constructed as to occupy as small a space as possible, and yet to afford all the space necessary inside to insure a proper application of the water to the wheel. It is so arranged that in case anything is wrong with the wheel it can readily be opened and the remedy applicd. With this case the wheel can be set at any distance within the range of three feet from the hottom of the fall. It can be located in any part of the mill under the top of the fall, and the water convcyed to it by pipes of appropriate size.

Explanation of Table for Small Wheels.

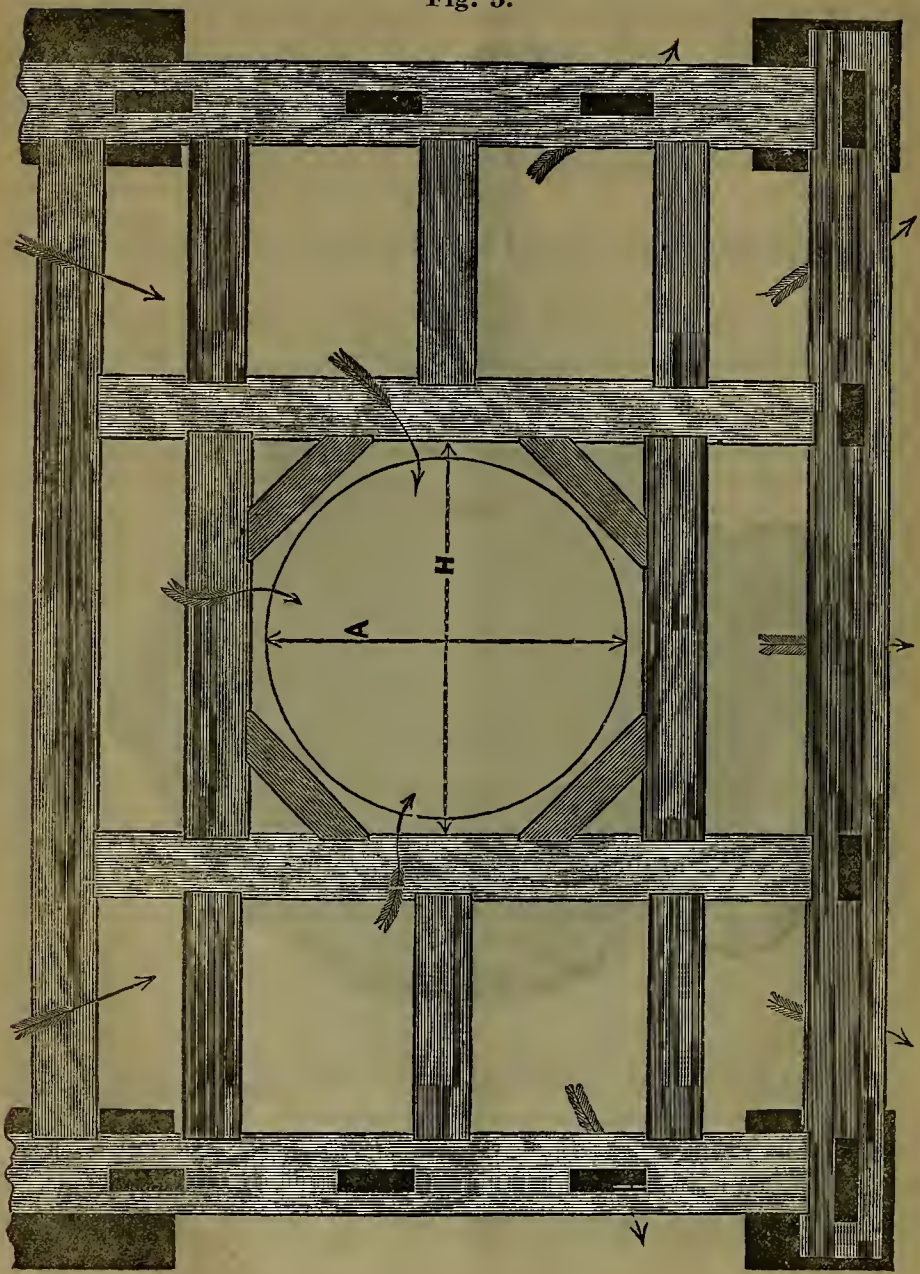
As we freqnently are asked what power can be obtained from falls ranging from 40 to 100 feet, we have therefore carefully computed the table to be found on page 16. This table gives the power, quautity of water used per minute, and number of revolutions per minute, nuder all falls from 41 to 100 feet, for eight different sizes, wheels from 5¾ iuches to 15¼ inches in diameter. To ascertain the power, etc., of these same sizes of wheels, for 40 feet fall and uuder, see tables on pages 12 to 15. Where wheels are to be used for over 100 feet head, we will calculate the horse-power, etc., for parties desiring to use snch falls.

Fig. 4.

Improved Patent Globe Casing.

Usually used now in flour mills or in mills employing upright shafts. Its application is so general that it needs no explanation. It is applied to Penstock in the same manner as the Horizontal Case or Penstock.

Fig. 5.



Construction of Lower Timbers and Floor of Flume.

Explanation of Fig. 5.

This cut is designed to give a general idea of the proper manner for framing the bottom of penstocks for our wheels. These plans will give the millwright or mill-owner a good insight of the method in which the timbers immediately around the cylinder of the wheel should be framed. A number of other ways by which the bottom of the penstock may be framed to suit certain locations, will readily occur to a practical millwright.

In no case should light, weak timbers be used for the bottom of penstocks. The side sills should be 12 to 14 inches square, providing 12 inch square posts are used, which will be heavy enough for 10 to 15 feet head. For 12 by 14 inch sills, 12 inch posts may be used. If the corner posts are rabbeted, they should be 12 by 14, or 14 by 16 inches square, so as to rabbet four inches one way and two inches the other. The intermediate sills may be narrow one way and placed edgewise up and down; and in large flumes these may be supported by two or three posts of stiff, hard timber, four to six six inches square, placed solidly on the foundations. In column H, page 6, will be found the distance, in inches, that these timbers should be framed apart for each sized wheel. For the size of the penstock, see the same page.

In the case of large penstocks, we would advise that they should rest either on stone pillars or side walls; but pillars are decidedly the best, especially where the tail-race or wheel-pit can be made wider than the penstock, as they allow a free discharge of water in all directions.

For the floor of the flume, 2½ to 3 inch planks should be laid on the sills of the penstock and spiked down. A hole must be cut in this floor, of sufficient size to allow the cylinder of the wheel to pass through. The diameter of this hole is given in column H, page 6. Surrounding the hole, soft pine planks should be placed, extending a little beyond the flanges of the wheel, and beveled. These planks must be leveled and planed off perfectly true. The flange of the wheel rests upon the planks, the cylinder passing down through the hole, and its end dipping two or more inches below the surface of standing tail-water. No fastening is necessary to keep the wheel in position, as its own weight and the pressure of the water will hold it firmly in place.

Actual Discharge of Water as Compared with Openings.

A well-constructed Turbine Wheel does not discharge a quantity of water equal to its full measurement of apertures; or, in other words, in order for a well-constructed Turbine to discharge a quantity of water equal to that which would flow through an orifice of a certain size under a given fall, and where the discharge is free and unobstructed, the apertures in the wheel must greatly exceed that of the simple orifice. The quantity of water discharged by different Turbines varies according to their construction. The controlling cause of this difference is the varying forms—curves and angles—given to the guides and buckets. The actual discharge of the Leffel Wheel is six-tenths of the combined area of its apertures. Suppose we take a wheel in which the total area of the apertures between its guides amounts to 100 square inches; now, this wheel will not discharge a quantity of water equal to 100 square inches, but only equal to 60 square inches. It must be evident to every one that this difference results from the water being retarded in its flow through the guides by coming in contact with the wheel within the casing. To make this clear, even to those who are not fully versed in hydraulics, let us suppose a wheel the apertures of whose guides measure 100 square inches, and place it under any given fall. Now, remove the wheel from out the casing, and open the guides; the water will then flow freely and unobstructedly through the guides into the empty space within the casing; as there is nothing to retard its flow, it will rush through the guides with a velocity due to the head under which it is placed. By placing the wheel again within the casing, it acts as a clog or check to the flow of water, as the water comes in contact with the buckets of the wheel, and instead of passing through the guides with the same velocity as before, it is held back, so that it now passes through the guides with only six-tenths its former velocity. Consequently, in order that a Turbine should discharge a certain quantity of water, the area of the apertures must greatly exceed that of the aperture that would discharge the same quantity under the same head, when allowed to flow into the open air freely and unretarded. The only reliable and certain means of ascertaining the quantity of water that a Turbine of any established proportions will discharge, is by actual measurement of the water after passing through the wheel. The tables we publish of the quantity of water used by our wheels, are not the result of a mere measurement of their apertures, and a consequent computation by theory, but are the results of numerous and repeated experiments, and actual measurements of water after passing from each wheel; and the quantities, as laid down in our tables, will be found, on trial, not to vary in any material amount from the quantity stated.

Table Specially Arranged, Expressly for James Leffel's Improved Double Turbine.

HEAD	SIZE OF WHEELS.	6¾	7⅞	8¾	10	11½	13¼	15¼	17½	20	23	26½	30½
3	Horse Power.	.15	.20	.25	.33	.44	.58	.76	.97	1.3	1.7	2.2	3.0
	Cubic Feet...	29	39	49	67	87	116	151	197	260	347	451	602
	Revolutions..	360	313	273	239	207	180	157	136	119	104	90	78
4	Horse Power.	.22	.30	.38	.52	.67	.90	1.1	1.5	2.0	2.6	3.5	4.6
	Cubic Feet...	33	45	57	57	100	134	174	227	301	401	521	695
	Revolntions..	416	362	315	275	240	208	181	158	138	119	104	90
5	Horse Power.	.31	.42	.53	.72	.94	1.2	1.6	2.1	2.8	3.7	4.8	6.5
	Cubic Feet...	37	50	64	86	112	149	194	254	336	448	583	777
	Revolntions..	465	405	352	308	268	233	202	176	154	134	116	101
6	Horse Power.	.41	.56	.70	.95	1.2	1.6	2.1	2.8	3.7	4.9	6.4	8.5
	Cubic Feet...	41	55	70	94	123	164	213	278	368	491	638	851
	Revolutions..	510	444	386	337	293	255	221	193	169	147	127	111
7	Horse Power.	.52	.70	.88	1.1	1.5	2.0	2.7	3.5	4.6	6.2	8.1	10.8
	Cubic Feet...	44	60	75	102	133	177	230	301	398	531	690	920
	Revolntions..	551	478	417	364	317	275	239	208	182	159	138	120
8	Horse Power.	.63	.86	1.0	1.4	1.9	2.5	3.3	4.3	5.7	7.6	9.0	13.2
	Cubic Feet...	47	64	80	109	144	189	246	321	425	567	737	983
	Revolutions..	588	511	446	390	339	294	256	223	195	169	147	128
9	Horse Power.	.76	1.0	1.2	1.7	2.2	3.0	3.9	5.1	6.8	9.0	11 8	15.7
	Cubic Feet...	50	68	85	115	150	201	261	341	451	602	782	1043
	Revolutions..	624	542	473	414	359	312	271	236	207	180	156	136
10	Horse Power.	.89	1.2	1.5	2.0	2.6	3.5	4.6	6.0	7.9	10.6	13.8	18.4
	Cubic Feet...	53	71	90	122	159	211	275	359	476	634	824	1099
	Revolutions..	658	572	498	436	379	329	286	249	218	190	164	143
11	Horse Power.	1.0	1.3	1.7	2.3	3.0	4 0	5.3	6.9	9.2	12.2	15.9	21.2
	Cubic Feet...	55	75	94	128	166	222	288	377	499	665	864	1153
	Revolutions..	690	600	523	457	307	345	300	261	229	199	173	150
12	Horse Power.	1.1	1.6	1.9	2.6	3 5	4.6	6.0	7.9	10.4	13.9	18.1	24.2
	Cubic Feet...	58	78	98	133	174	232	301	393	521	695	903	1204
	Revolutions	721	626	546	473	415	360	313	273	239	208	180	157
13	Horse Power.	1.3	1.7	2.2	3.0	3.9	5.2	6.8	8.9	11.8	15.7	20.5	27.3
	Cubic Feet...	60	81	102	139	181	241	313	410	542	723	940	1253
	Revolutions..	750	652	568	497	432	375	326	284	249	217	188	163
14	Horse Power.	1.5	1.9	2 5	3.3	4.4	5.8	7.6	10.0	13.2	17.6	22.9	30.5
	Cubic Feet...	63	84	106	144	188	250	325	425	563	750	975	1300
	Revolutions..	779	677	590	516	448	389	338	295	258	224	195	169
15	Horse Power.	1.6	2.2	2.7	3.7	4.8	6 5	8.4	11 0	14.6	19.5	25.4	33.8
	Cubic Feet...	65	87	110	149	194	259	337	440	582	777	1009	1346
	Revolntions..	806	700	610	534	464	403	350	305	267	232	201	175
16	Horse Power.	1.7	2.4	3 0	4.1	5.3	7.1	9.3	12.2	16 1	21.5	28 0	37 3
	Cubic Feet...	67	90	114	154	201	267	348	455	602	802	1043	1390
	Revolutions..	832	723	630	551	479	416	362	315	276	240	208	181
17	Horse Power.	1.9	2.6	3.3	4.5	5.9	7.8	10.2	13.3	17.6	23.5	30.6	40.8
	Cubic Feet...	69	93	117	159	207	276	358	469	620	827	1075	1433
	Revolutions.	869	745	650	568	494	429	373	325	284	242	214	187
18	Horse Power.	2.1	2.8	3.6	4.9	6.4	8.5	11.1	14.5	19.2	25.7	33.4	44.5
	Cubic Feet...	71	94	121	163	213	284	369	482	638	851	1106	1475
	Revolutions..	883	767	668	585	508	441	384	334	293	254	221	192
19	Horse Power.	2.3	3.1	3.9	5.3	6.9	9.2	12.0	15.7	20.9	27.8	36.2	48.3
	Cubic Feet...	73	98	124	168	219	291	379	495	656	874	1136	1515
	Revolutions..	907	788	687	601	522	454	394	343	300	261	227	197
20	Horse Power.	2.5	3.3	4.2	5.7	7.5	10.0	13.0	17.0	22.5	30.1	39.1	52.1
	Cubic Feet...	75	101	127	172	224	299	389	508	673	897	1166	1554
	Revolutions..	931	809	704	617	536	465	405	352	308	268	233	202
21	Horse Power.	2.7	3.6	4.5	6.2	8.1	10.7	14.0	18 3	24.2	32 3	42.1	56.1
	Cubic Feet...	77	103	130	176	230	306	398	521	689	919	1194	1592
	Revolutions..	954	828	722	632	549	477	414	361	316	275	238	207

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Table Specially Arranged, Expressly for James Leffel's Improved Double Turbine.

HEAD.	SIZE OF WHEELS.	35	40	44	48	52	56	61	66	74	84	96
3	Horse Power.	3.9	5.2	5.9	7.5	9.8	13.1	15.1	18.1	22.0	29.0	37.9
	Cubic Feet.	793	1042	1213	1506	1956	2556	3010	3612	4119	5761	7528
	Revolutions.	68	60	55	50	44	42	40	36	32	28	25
4	Horse Power.	6.1	8.0	9.4	11 6	15.1	19.7	23 3	28.0	34.3	44.7	58.5
	Cubic Feet.	916	1203	1400	1738	2259	2931	3416	4170	5106	6662	8690
	Revolutions.	79	69	63	57	53	49	45	40	37	33	29
5	Horse Power.	8 5	11 2	13.1	16.3	21.1	27.6	32.6	39.1	47.8	62 4	81.5
	Cubic Feet.	1023	1345	1568	1942	2525	3273	3881	4602	57.6	7440	9710
	Revolutions.	88	77	70	64	60	55	50	44	41	37	32
6	Horse Power	11 2	14.8	17.2	21.4	27.8	36.3	42.8	51.4	62.9	82.0	107.1
	Cubic Feet.	1121	1473	1717	2128	2766	3587	4256	5109	6247	8152	10640
	Revolutions.	96	81	77	70	66	60	55	47	45	40	35
7	Horse Power.	14.2	18.8	21.9	27.0	35.1	45.7	54.0	64.8	79.3	103.4	135.0
	Cubic Feet.	1211	1592	1857	2299	2986	3875	4598	5520	6760	8817	11495
	Revolutions.	104	91	83	77	70	65	60	50	49	43	38
8	Horse Power.	17.3	22.8	26.6	32.9	42.8	55.9	65.9	79.2	96.9	126.4	164.9
	Cubic Feet.	1295	1701	1978	2457	3194	4143	4914	5898	7214	9415	12285
	Revolutions.	111	97	89	81	76	69	64	54	53	46	41
9	Horse Power.	20.7	27.2	31 8	39.3	51.1	66.7	78.7	94.5	115.6	150.8	196.8
	Cubic Feet.	1373	1804	2110	2607	3339	4457	5214	6258	7659	9994	13035
	Revolutions.	118	103	94	86	80	74	98	58	56	49	43
10	Horse Power.	24 3	31.9	37.2	46.1	59 9	78 1	92 2	110.6	135.4	176.7	230.5
	Cubic Feet.	1448	1902	2211	2747	2571	4646	5494	6594	8075	10534	13735
	Revolutions.	125	109	100	91	86	78	71	63	59	52	46
11	Horse Power.	28.0	36 8	45.0	53 2	69.1	90.2	106 4	127.6	156.2	203.8	266.0
	Cubic Feet.	1518	1995	2324	2882	3740	4857	5764	7783	8472	11057	14410
	Revolutions.	132	114	104	95	90	82	75	67	62	54	48
12	Horse Power.	31.9	41.9	49.3	60.6	78.7	102.7	121.2	145.4	178.1	232.3	303.0
	Cubic Feet.	1586	2083	2426	3009	3912	5075	6018	7224	8839	11541	15045
	Revolutions.	136	119	109	99	94	85	78	72	65	57	50
13	Horse Power.	36 0	47.3	55.1	68.3	88.8	115.8	136.6	163.9	200.8	261.9	341.6
	Cubic Feet.	1650	2168	2529	3132	4072	5282	6264	7518	9207	12006	15660
	Revolutions.	142	124	114	104	99	89	81	75	67	59	52
14	Horse Power.	40 2	52 8	61.6	76.3	99.8	129.5	152 7	183 3	224.4	292.7	381.9
	Cubic Feet.	1713	2251	2622	3251	4226	5481	6502	7800	9555	12461	16255
	Revolutions.	148	129	118	107	102	92	84	78	70	61	54
15	Horse Power.	44.6	58.6	68.4	84.7	110.1	143.6	169.4	203.2	248.9	324.6	423.5
	Cubic Feet.	1773	2330	2716	3365	4374	5673	6730	8076	9883	12898	16825
	Revolutions.	153	133	122	111	106	97	86	80	72	64	56
16	Horse Power.	49.1	64.6	75.3	93.3	121.3	158.2	186.6	223 9	274.1	357.7	466 6
	Cubic Feet.	1831	2406	2809	3475	4518	5858	6950	8340	10222	13324	17375
	Revolutions.	158	138	126	115	110	99	90	82	74	66	58
17	Horse Power.	53.8	70.7	82.6	102.2	132.8	173.1	204.4	245 3	300 3	391.7	511.0
	Cubic Feet.	1888	2480	2893	3583	4658	6041	7166	8598	10532	13733	17915
	Revolutions.	162	142	130	118	112	101	93	85	77	68	59
18	Horse Power.	58.6	77.1	89.8	111 3	144 7	188.8	222.7	267.3	327.2	426.8	556.8
	Cubic Feet.	1943	2552	2977	3687	4793	6220	7374	8850	10831	14131	18435
	Revolutions.	167	146	134	122	115	104	96	87	79	70	61
19	Horse Power.	63 6	83.6	97.5	120.7	157.0	209.7	241.5	289.8	354.8	462.8	603.8
	Cubic Feet.	1996	2622	3051	3787	4923	6387	7574	9090	11131	14531	18935
	Revolutions.	172	150	137	125	117	107	98	89	81	72	63
20	Horse Power.	68.7	90.3	106.3	130.4	169.5	221.1	260.8	313.0	383.3	499.9	652.1
	Cubic Feet.	2048	2690	3136	3885	5051	6553	7770	9325	11421	14900	19425
	Revolutions.	176	154	141	128	119	110	101	91	83	73	64
21	Horse Power.	73.9	97.1	116.8	140.3	182.4	237.8	280.6	336.7	414.9	534.3	701.6
	Cubic Feet.	2098	2756	3214	3981	5175	6713	7962	9552	11768	15158	19905
	Revolutions.	180	158	145	132	122	112	103	93	85	74	66

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HEAD.	SIZE OF WHEELS.	6⅝	7⅝	8¾	10	11⅛	13¼	15¼	17½	20	23	26⅛	30½
22	Horse Power.	2.9	3.9	4.9	6.6	8.6	11.5	15.0	19.6	26.0	34.7	45.1	60.1
	Cubic Feet...	78	106	133	180	235	313	407	533	705	940	1223	1630
	Revolutione..	976	847	739	647	567	488	424	369	323	281	244	211
23	Horse Power.	3.1	4.1	5.2	7.1	9.2	12.0	16.0	21.0	27 8	37.1	48.2	64.3
	Cubic Feet...	80	108	136	184	241	321	417	545	721	962	1259	1667
	Revolutione..	998	867	756	661	574	499	433	378	331	287	249	217
24	Horse Power.	3.3	4.4	5 6	7.5	9.8	13.1	17.1	22.4	29.6	39.5	51.4	68 5
	Cubic Feet...	82	111	139	188	246	327	426	557	737	982	1277	1703
	Revolutions..	1019	886	772	675	587	510	443	386	338	294	255	221
25	Horse Power	3.5	4.7	5.9	8 0	10.5	14.0	18.2	23.8	31.5	42.0	54.6	72.9
	Cubic Feet...	84	113	142	192	251	334	434	568	752	1003	1306	1738
	Revolutions..	1040	984	788	689	599	520	452	394	345	300	260	226
26	Horse Power.	3.7	5.6	6.3	8.5	11.1	14.8	19.3	25.2	33.4	44.6	57.9	77.3
	Cubic Feet...	85	115	144	196	256	341	443	579	767	1022	1329	1772
	Revolutions..	1061	922	803	703	611	530	461	402	341	306	265	230
27	Horse Power.	3.9	5.3	6.6	9.0	11.8	15.7	20.4	26.7	35.4	47.2	61 3	81.8
	Cubic Feet...	87	117	148	200	260	347	451	590	781	1042	1354	1806
	Revolutions..	1081	939	819	716	622	540	470	409	358	311	270	235
28	Horse Power.	4.1	5.6	7.0	9.5	12.4	16.6	21.6	28.2	37.3	49.8	64.8	86.4
	Cubic Feet...	88	119	150	203	265	354	460	602	796	1061	1379	1838
	Revolutions..	1101	956	835	729	634	550	478	417	365	317	275	239
29	Horse Power.	4.3	5.9	7.4	10.0	13.1	17.5	22 7	29.7	39.4	52.5	68.3	91.0
	Cubic Feet...	90	121	153	207	270	360	468	612	810	1079	1404	1871
	Revolutions..	1120	973	848	744	645	560	487	424	371	323	280	243
30	Horse Power.	4.6	6.2	7.8	10.6	13.8	18.4	23.9	31.3	41.4	55.3	71.8	95.8
	Cubic Feet...	92	124	156	211	275	365	476	622	824	1098	1428	1904
	Revolutions..	1140	990	863	755	656	570	495	431	378	328	285	248
31	Horse Power.	4.8	6.5	8.2	11.1	14.5	19.3	25.1	32.9	43.5	58.0	75 5	100.6
	Cubic Feet...	93	126	158	214	279	372	484	633	837	1117	1451	1935
	Revolutions..	1158	1007	877	767	667	579	503	439	384	334	290	252
32	Horse Power.	5.0	6.8	8.6	11.6	15.2	20 3	26.4	34 5	45.6	60.9	79.1	105.5
	Cubic Feet...	95	128	161	217	284	378	492	643	851	1134	1475	1966
	Revolutions..	1177	1024	891	780	678	589	511	446	390	339	294	256
33	Horse Power.	5.3	7.1	9.0	12.2	15.9	21.2	27.6	36.1	47.8	63.7	82.9	110.5
	Cubic Feet...	96	130	163	221	288	384	499	653	864	1152	1497	1996
	Revolutions..	1195	1039	905	792	688	598	519	453	396	344	299	260
34	Horse Power.	5.5	7.5	9.4	12.7	16.6	22.2	28.9	37.8	50.0	66.7	86.7	115 6
	Cubic Feet...	97	132	166	224	292	390	507	663	877	1169	1520	2027
	Revolutione..	1213	1055	919	804	699	607	527	459	402	350	303	264
35	Horse Power.	5.8	7.8	9.8	13.3	17.4	23.2	30.2	39.5	52.2	69.7	90.6	120.8
	Cubic Feet...	99	134	168	227	297	396	514	672	890	1186	1542	2057
	Revolntions..	1231	1070	932	816	709	616	535	466	408	355	308	268
36	Horse Power.	6.0	8.1	10.3	13.6	18.1	24.2	31.5	41.1	54.5	72 6	94.4	125.9
	Cubic Feet...	100	139	171	231	301	401	521	682	902	1203	1564	2085
	Revolutions.	1249	1085	945	827	719	624	542	473	414	360	312	271
37	Horse Power.	6.3	8.5	10.7	14.5	18.9	25.2	32.8	42.9	56.8	75.7	98.4	131.2
	Cubic Feet...	102	137	173	234	305	407	528	691	915	1220	1585	2114
	Revolutions..	1266	1100	958	838	729	633	550	479	419	365	316	275
38	Horse Power.	6.5	8.8	11.1	15.1	19.7	26.2	34.1	44.9	59.1	78.8	102.4	136.6
	Cubic Feet...	103	139	175	237	308	412	536	700	927	1236	1607	2142
	Revolutions..	1283	1115	971	850	738	641	557	486	425	369	321	279
39	Horse Power.	6.8	9.2	11.6	15.7	20.4	27.3	35.5	46.4	61 4	81.9	106.5	142.0
	Cubic Feet...	104	141	177	240	313	417	543	710	939	1252	1628	2170
	Revolutions .	1299	1129	984	861	748	650	564	492	430	374	325	281
40	Horse Power.	7.0	9.5	12.0	16.3	21.2	28.3	36.8	48.2	63.8	85.1	110.6	147.7
	Cubic Feet...	106	143	180	243	317	428	550	719	951	1268	1648	2198
	Revolutions..	1316	1144	996	874	758	658	572	498	436	379	329	286

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HEAD.	SIZE OF WHEELS.	35	40	44	48	52	56	61	66	74	84	96
22	Horse Power	79.2	104.1	125.2	150.4	195.5	255.1	300.8	361.0	444.8	572.8	752.2
	Cubic Feet	2147	2821	3393	4074	5297	6851	8148	9798	12049	15510	20370
	Revolutions	185	162	148	135	125	116	106	95	86	76	67
23	Horse Power	84.7	111.3	133.9	160.8	209.0	272.6	321.6	388.1	475.5	612.2	804.1
	Cubic Feet	2195	2884	3470	4166	5416	7023	8332	10002	12322	15862	20830
	Revolutions	189	165	151	138	128	118	108	97	88	77	69
24	Horse Power	90.3	118.6	142.7	171.4	222.8	290.5	342.8	411.4	506.9	652.7	857.2
	Cubic Feet	2243	2947	3545	4256	5533	7175	8512	10218	12589	16214	21280
	Revolutions	193	169	155	141	131	121	110	100	90	79	70
25	Horse Power	96.0	126.1	151.7	182.2	236.9	309.1	364.5	437.4	538.9	693.8	911.3
	Cubic Feet	2289	3007	3618	4344	5647	7325	8688	10428	12847	16544	21720
	Revolutions	197	172	158	144	134	123	113	102	91	81	72
26	Horse Power	101.8	133.8	160.9	193.3	251.3	330.2	386.6	463.9	572.1	734.8	966.5
	Cubic Feet	2334	3067	3688	4430	5759	7466	8860	10632	13098	16874	22150
	Revolutions	201	176	161	146	136	126	115	105	93	82	73
27	Horse Power	107.7	141.6	170.3	204.5	265.9	346.8	408.1	490.9	604.8	779.0	1022.8
	Cubic Feet	2379	3125	3760	4514	5868	8612	9028	10836	13349	17182	22570
	Revolutions	205	179	164	149	138	128	117	108	95	84	74
28	Horse Power	113.8	149.5	179.8	216.0	280.8	366.1	432.0	518.4	638.6	822.4	1080.0
	Cubic Feet	2422	3182	3826	4597	5976	7749	9194	11028	13587	17511	22985
	Revolutions	208	182	167	152	139	130	119	110	97	85	76
29	Horse Power	119.9	157.6	189.5	227.6	295.7	386.0	455.3	546.4	673.1	867.0	1138.3
	Cubic Feet	2465	3238	3890	4678	6081	7887	9356	11226	13830	17820	23390
	Revolutions	212	168	170	155	142	132	121	113	99	87	77
30	Horse Power	126.2	165.8	199.5	239.6	311.5	406.3	479.2	595.1	708.5	912.3	1198.1
	Cubic Feet	2508	3295	3964	4759	6187	8025	9518	11424	14074	18128	23795
	Revolutions	216	189	173	157	145	135	124	115	100	88	78
31	Horse Power	132.6	174.2	209.6	251.6	327.1	427.9	503.3	605.1	744.2	958.1	1258.2
	Cubic Feet	2549	3349	4025	4837	6288	8157	9674	11610	14340	18414	24185
	Revolutions	219	192	176	160	147	137	126	117	102	90	80
32	Horse Power	139.0	182.7	219.7	263.9	343.1	440.0	527.9	633.4	780.4	1005.1	1319.8
	Cubic Feet	2590	3403	4093	4915	6390	8330	9830	11796	14533	18722	24575
	Revolutions	223	195	178	162	150	139	128	120	104	91	81
33	Horse Power	145.6	191.3	230.1	276.4	359.3	469.1	552.8	663.4	817.3	1052.4	1382.1
	Cubic Feet	2630	3455	4155	4991	6488	8412	9982	11976	14755	19008	24955
	Revolutions	226	198	181	165	153	142	130	122	105	93	82
34	Horse Power	152.2	200.1	240.7	289.1	375.9	490.2	578.2	693.9	854.8	1100.8	1445.5
	Cubic Feet	2670	3508	4224	5067	6587	8593	10134	12162	14984	19294	25335
	Revolutions	230	201	184	167	155	144	132	124	107	94	83
35	Horse Power	159.1	209.0	251.4	302.0	392.6	512.7	604.0	724.8	893.0	1149.9	1510.1
	Cubic Feet	2709	3560	4282	5142	6684	8731	10284	12342	15205	19580	25710
	Revolutions	233	204	187	170	158	147	134	126	108	96	85
36	Horse Power	165.9	218.0	262.2	314.9	409.4	537.9	629.9	755.8	931.2	1199.2	1574.7
	Cubic Feet	2747	3609	4341	5213	6777	8818	10426	12510	15413	19844	26065
	Revolutions	236	207	189	172	160	149	136	128	110	97	86
37	Horse Power	172.9	227.1	273.2	328.1	426.6	550.6	656.3	787.5	970.2	1249.6	1640.5
	Cubic Feet	2785	3658	4401	5286	6871	8951	10572	12684	15626	20130	26430
	Revolutions	240	210	192	175	162	150	137	130	111	98	87
38	Horse Power	179.9	236.4	284.9	341.5	444.0	580.2	683.1	819.7	1009.9	1300.6	1707.9
	Cubic Feet	2822	3708	4459	5356	6963	9075	10712	12852	15733	20394	26780
	Revolutions	243	212	194	177	165	153	139	133	113	100	88
39	Horse Power	187.1	245.8	295.6	355.1	461.6	612.3	710.2	852.2	1049.9	1352.1	1775.5
	Cubic Feet	2859	3756	4517	5425	7053	9193	10850	13020	16041	20658	27125
	Revolutions	246	215	197	179	167	155	141	135	114	101	89
40	Horse Power	194.3	255.3	307.1	368.8	479.5	629.8	737.7	885.1	1090.5	1404.4	1844.3
	Cubic Feet	2895	3804	4576	5495	7143	230	10990	13188	16248	20922	27475
	Revolutions	249	218	200	182	170	157	143	137	116	102	91

In ordering our wheels, please state whether the wheel must run WITH or AGAINST the sun.

From left to right is with the sun, and from right to left is against the sun.

TABLE FOR SMALL WHEELS FROM 5¾ TO 15¼ INCHES DIAMETER.

Showing Horse Power, Cubic Feet of Water, and Revolutions per Minute, from 41 to 100 Feet Head.

HEAD.	5¾			6⅝			7⅝			8¾			10			11½			13¼			15¼		
	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.	H. P'r.	Rev'ns	Cu. Ft.
41	5.5	1534	80	7.2	1332	108	9.8	1158	145	12.5	1008	182	17.0	882	246	22.0	767	321	29.0	665	428	37.9	579	556
42	5.7	1552	81	7.4	1348	109	10.0	1163	146	13.0	1020	184	17.6	893	249	22.8	776	324	30.3	674	433	39.0	586	562
43	5.9	1570	82	7.8	1364	110	10.2	1178	148	13.4	1032	186	17.9	903	253	23.7	785	328	31.0	682	438	40.5	593	569
44	6.0	1588	83	8.0	1380	112	10.6	1200	150	14.0	1046	188	18.2	914	256	24.0	794	332	32.0	690	444	42.0	600	576
45	6.2	1606	84	8.3	1396	113	10.9	1212	152	14.4	1058	190	18.5	924	258	24.8	803	336	33.5	698	449	43.6	606	584
46	6.4	1624	85	8.5	1412	114	11.0	1225	153	15.0	1070	191	19.0	934	261	25.6	812	340	35.6	706	454	45.0	613	591
47	6.6	1642	86	8.9	1428	115	11.4	1237	155	15.6	1082	193	19.5	945	264	26.4	821	344	36.4	714	460	47.1	620	596
48	6.8	1660	87	9.2	1442	116	12.0	1252	156	16.1	1092	196	20.4	956	266	27.3	830	348	38.0	720	464	48.6	626	602
49	7.0	1676	88	9.5	1458	117	12.2	1265	157	16.5	1104	198	21.0	965	269	28.0	838	352	39.1	727	469	50	633	609
50	7.2	1694	89	9.8	1474	119	12.4	1277	159	17.0	1116	200	21.6	974	272	28.9	847	356	40.3	735	474	52.1	640	616
51	7.5	1710	90	10.1	1490	120	12.8	1289	161	17.5	1128	203	22.0	983	275	29.7	855	360	40.9	743	478	54.3	646	622
52	7.9	1728	91	10.4	1500	121	13.3	1304	162	18.0	1136	204	22.8	994	278	31.6	864	363	41.5	750	482	55.2	652	626
53	8.0	1744	92	10.7	1515	122	13.7	1317	164	18.5	1146	206	23.6	1003	280	32.1	872	366	42.6	757	487	56.4	658	632
54	8.4	1760	92	11.0	1531	123	14.0	1328	165	19.0	1156	208	24.5	1012	283	33.6	880	371	43.6	764	491	58.0	664	638
55	8.5	1776	93	11.3	1546	125	14.5	1342	167	19.6	1166	210	25.4	1021	286	34.0	888	375	44.8	771	495	59.5	670	644
56	8.6	1792	94	11.6	1558	126	15.0	1354	168	20.0	1180	212	26.0	1032	288	34.6	896	378	46.0	778	500	61.3	676	650
57	8.9	1808	95	11.9	1572	127	15.4	1366	170	20.6	1193	213	26.8	1041	291	35.5	904	382	47.4	785	504	62.8	682	656
58	9.1	1824	96	12.2	1588	128	16.0	1378	172	21.0	1203	216	27.6	1050	293	36.4	912	386	48.7	792	509	64.0	688	662
59	9.2	1840	97	12.5	1598	129	16.6	1390	173	21.5	1212	218	28.4	1059	296	37.0	920	390	50.1	799	513	66.0	694	669
60	9.5	1856	98	12.8	1612	130	17.0	1400	174	22.1	1220	220	29.0	1068	298	38.0	928	391	51.3	806	518	68.0	700	674
61	9.7	1872	98	13.0	1625	131	17.3	1412	176	22.5	1230	221	29.8	1077	300	38 9	936	393	52.5	813	523	69.8	706	680
62	10.0	1886	99	13.3	1637	132	17.8	1423	177	23.1	1240	223	30.6	1086	303	40.0	943	396	53.2	819	528	71.5	712	687
63	10.2	1902	100	13.6	1650	133	18.2	1435	179	23.6	1250	226	31.6	1095	306	41.0	951	399	55.0	826	533	73.2	718	693
64	10.5	1916	100	14.0	1664	134	18.5	1449	180	24.5	1260	228	32.0	1102	308	42.3	958	402	56.4	832	535	75.0	724	696
65	10.7	1930	101	14.2	1676	135	19.0	1456	182	25.3	1270	230	33.8	1110	311	43.2	965	405	57.6	838	538	77.0	730	700
66	11.0	1946	102	14.6	1689	136	19.4	1465	184	26.0	1281	232	34.6	1118	314	44.4	973	408	58.9	845	543	79.1	735	706
67	11.3	1960	103	14.7	1702	137	19.8	1478	185	26.6	1290	233	35.0	1127	316	45.0	980	411	60.0	851	547	81.2	740	711
68	11.5	1976	104	15.0	1716	138	20.2	1490	186	27.0	1300	234	35.5	1136	318	46.3	988	414	62.1	858	552	82.2	746	716
69	11.7	1990	105	15.4	1728	139	20.4	1599	188	27.4	1309	236	36.0	1144	321	47.0	995	417	63.9	864	556	83.8	751	720
70	12.1	2004	105	15.9	1740	140	20.7	1511	189	28.0	1318	237	36.7	1152	323	48.5	1002	420	65.0	870	561	85.0	757	725
71	12.4	2018	106	16.3	1752	141	21.3	1533	190	28.5	1327	239	37.6	1160	325	49.6	1009	423	65.1	876	565	86.9	762	730
72	12.6	2032	107	16.5	1776	142	22.0	1534	192	29.0	1336	242	38.2	1170	326	50.5	1016	426	67.3	882	570	89.0	768	738
73	12.9	2046	107	16.8	1778	143	22.5	1545	193	29.6	1345	244	39.0	1178	328	51.6	1023	429	68.5	888	574	91.1	773	742
74	13.1	2060	108	17.0	1790	144	22.8	1556	194	30.8	1354	245	40.8	1186	331	52.7	1030	432	70.0	895	577	93.1	778	748
75	13.6	2074	109	17.5	1802	145	23.5	1566	195	31.4	1363	246	41.0	1194	334	54.6	1037	435	72.4	902	579	92.2	783	753
76	13.8	2088	110	18.0	1814	146	24.0	1576	196	32.0	1374	248	41.6	1202	336	55.0	1044	438	73.2	908	582	97.0	788	758
77	14 0	2102	110	18.4	1826	147	24.5	1586	198	32.5	1383	250	42.4	1201	338	56.0	1051	440	74.8	914	585	99.0	793	764
78	14.2	2116	111	18.7	1838	148	25.0	1597	199	33.0	1392	252	43.0	1218	340	57.0	1058	443	76.0	920	588	101.0	798	770
79	14.5	2130	111	19.0	1850	149	25.5	1608	200	33.6	1400	253	44 0	1226	342	58.1	1065	445	77.4	926	593	103.3	803	774
80	14.8	2144	112	19.5	1862	150	26.0	1618	202	34.0	1408	254	45.0	1234	344	59.0	1072	448	79.1	930	598	105.1	808	778
81	15.0	2156	112	20.0	1874	151	26.5	1626	203	34.8	1417	255	45.8	1242	346	60.5	1078	450	80.5	936	604	106.9	813	782
82	15.2	2168	113	20.4	1886	152	27.0	1636	204	35.6	1424	257	46.6	1250	348	61.6	1084	453	82.0	941	608	108.5	818	786
83	15.8	2180	114	20.8	1898	153	27.5	1646	205	36.5	1433	258	47.2	1257	350	63.0	1090	456	83.5	948	610	110.0	823	790
84	16.0	2196	115	21.0	1908	154	28.0	1656	206	37.1	1444	260	48.1	1264	352	64.1	1098	460	85.0	954	612	112.0	827	796
85	16.2	2210	116	21.4	1919	155	28.5	1666	207	37.7	1452	262	49.0	1272	354	65.9	1105	463	86.6	960	615	114.1	833	801
86	16.5	2222	116	21.8	1930	156	29.0	1674	208	38.2	1461	263	50.0	1280	356	66.2	1111	465	88.0	965	620	116.2	836	805
87	16.8	2236	117	22.2	1941	157	29.5	1684	210	39.0	1469	264	51.0	1287	358	67.3	1118	468	89.6	970	623	118.1	841	809
88	17.2	2248	118	22.6	1952	158	30.0	1694	212	39.7	1478	266	52 0	1294	360	68.6	1124	470	91.1	976	626	120.0	848	814
89	17.4	2258	118	23.1	1963	159	30.4	1704	213	40 3	1486	267	52.8	1301	362	69 4	1129	473	92.5	981	630	122.2	855	820
90	17 6	2270	119	23.6	1974	160	31.1	1714	214	41.0	1495	269	53.6	1308	364	70.8	1135	476	94.1	987	634	124.4	862	826
91	17.9	2280	120	24.0	1985	161	31.6	1724	215	41.5	1504	270	54.4	1315	366	71.9	1140	479	95.5	992	638	126.7	869	830
92	18.3	2296	121	24.3	1996	162	32.0	1734	216	42.2	1512	272	55 3	1322	368	73.2	1148	482	97.0	998	642	129.0	873	834
93	18.5	2310	121	24.8	2007	163	32.6	1743	217	42.8	1520	273	56.0	1329	370	74.1	1155	485	98.5	1004	645	131 1	876	839
94	18.9	2322	122	25 3	2017	164	33.0	1752	218	43.5	1528	275	56.9	1336	372	75.5	1161	488	99.2	1009	648	133.2	880	843
95	19.2	2334	122	25.7	2027	165	33.7	1761	219	44.0	1536	277	58.0	1343	374	76.8	1167	490	102.0	1015	651	135.0	886	847
96	19.5	2348	123	26.2	2038	166	34.2	1772	220	44.5	1544	278	59.1	1350	376	78.1	1174	492	104.2	1020	654	137.8	889	852
97	19.8	2360	124	26.5	2049	167	34.9	1780	221	45.1	1552	280	60.0	1357	378	79.1	1180	494	105.8	1025	657	140.0	893	856
98	20.1	2372	124	26.8	2060	168	35.5	1789	222	46.0	1560	281	61.0	1364	380	80.4	1186	497	107.2	1030	660	142.2	897	860
99	20.5	2384	125	27.0	2070	169	36.0	1797	224	46.9	1568	283	62.1	1371	382	82.0	1192	500	109.1	1035	664	144.2	900	864
100	20.8	2396	126	27.3	2080	170	36.6	1808	226	48.0	1576	285	64.0	1378	384	83.2	1198	502	110.8	1040	668	146.1	904	868

Explanation of the Foregoing Tables.

On page 5 is a cut illustrating the position and method of locating the wheel in open penstock or wood flumes: the following page, 6, gives a table of dimensions of the different parts of the different sized wheels, and sufficiently explains itself. On pages 12, 13, 14 and 15 will be found tables showing the power, number of revolutions per minute, and also the number of cubic feet of water discharged per minute, for each size of our wheels, under heads from 3 to 40 feet. The top line of figures shows the size of wheels from 6¾ to 96 inches diameter. The left-hand perpendicular columns give the head of water in feet from 3 to 21, and 21 to 40. In the small squares formed by intersection of the perpendicular and horizontal lines are three sets of figures. The upper one indicates the number of horse-power; the middle set of figures shows the number of cubic feet of water used by the wheel per minute, and the lower set of figures shows the number of revolutions of wheel per minute. This style and arrangement of tables was first introduced by James Leffel, and on account of its simplicity, compactness, beauty and convenience of reference, has been extensively copied and adopted by other wheel men.

We give an example of the manner of determining, by this table, the power, quantity of water used, and revolutions, of any sized wheel, under a given fall. Suppose we wanted to find the power of a 20 inch wheel under a 11 feet fall: find in the side line of figures, indicating the *fall in feet*, the fall required, 11 feet; now follow the horizontal column, opposite the figure 11, until you come to the perpendicular column in which the size of the wheel (20 inch wheel) is placed at the top. In the square where these two columns intersect will be found 9 and 2 *tenths* H. power; 499 cubic feet of water per minute; 229 revolutions per minute. The same method will determine the power, quantity of water used per minute, and number of revolutions per minute, of any size wheel under any fall from 3 to 40 feet.

Table of Small Wheels for Heads from 41 to 100 Feet.

On page 16 will be found a table showing the power, quantity of water, and revolutions per minute, for eight sizes of small wheels, from 5¾ inches to 15¼ inches diameter. It is somewhat differently arranged from those preceding it, for the purpose of getting the whole on one page, which perhaps has sacrificed some of the beauty and convenience of the former described tables. The same method of arranging the sizes of wheels and heads is observed as in the others; but the powers, water used and revolutions are upon the same horizontal line. An examination of it will readily enable any one to obtain the desired data.

Working Velocity of the Wheel.

The revolution of the wheels, as laid down in the foregoing tables, are the number of revolutions the wheel makes when at work. But as there is always a loss of fall by the water drawing down in the head race, and also rising in the tail race, when the wheel is running, we would advise those who have charge of putting in the wheels, that, in calculating for the speed of wheel and machinery, they always base their calculations on a fall of six inches to a foot less than the measured fall, when the head and fall are from four to twenty feet, and eighteen inches when the fall is over twenty feet; thus allowing for the loss of head mentioned, which will bring the speed of the wheel to suit the actual running head.

Explanation of Figures 6 and 7.

The design of Figure 7 is to show the many advantages gained by the use of our wheel over an overshot wheel, particularly on small streams and high falls; and to more clearly show this, we ask a careful comparison of the arrangement shown in this Cut with that shown in Cut 7, page 19. We have taken the same fall and same size of stream as shown in Figure 7.

Instead of using a 22 feet overshot, we would use one of our wheels 13¾ inches in diameter, which will give even more power than the 22 feet overshot wheel. The shaft of the overshot wheel must be at least two feet in diameter of wood, and at least ten inches diameter of iron. The shaft I on our wheel need not exceed 1¼ inches in diameter. Instead of the massive crown-wheel B, bevel-pinion E, and spur-wheel D, which together weigh several thousand pounds, we would use only a tension pulley (R) weighing only about thirty pounds, and run a belt direct to the pulley D on the spindle of the burr. The shaft H used with the overshot must be from four to eight inches diameter, in order to sustain the heavy strain resulting from a slow motion; while the same shaft H, when our wheel is used, need not exceed 2¼ inches in diameter, as we would give it a quick motion and reduce the speed upon the reels and other machinery; while from the slow speed of the overshot machinery a constant increase from a slow to faster speed is required, with our wheel the reverse is the case. It will be observed that in order to obtain the proper speed for the smutter and separator S, a large spur-wheel M, and pinion N, and pulley R, are necessary where an overshot wheel is used; but none of this gearing is necessary where our wheel is used, as our wheel will make nearly five hundred revolutions per minute. The pulley T on the water wheel shaft need not be but slightly larger than the pulley on the smutter S, which is usually about eight inches diameter.

It must be apparent to all, that by the use of our wheel not only is there much saved in the cost of machinery, but a great gain of power effected from the simplicity of the arrangement and such direct communication of the power to the work to be done; also great expense of freighting heavy shafting and machinery into the mountains, and a further expense of work in setting up the very heavy machinery. In the case of an overshot, the power is communicated through a vast amount of heavy

[*See page* 20.]

Fig. 6.

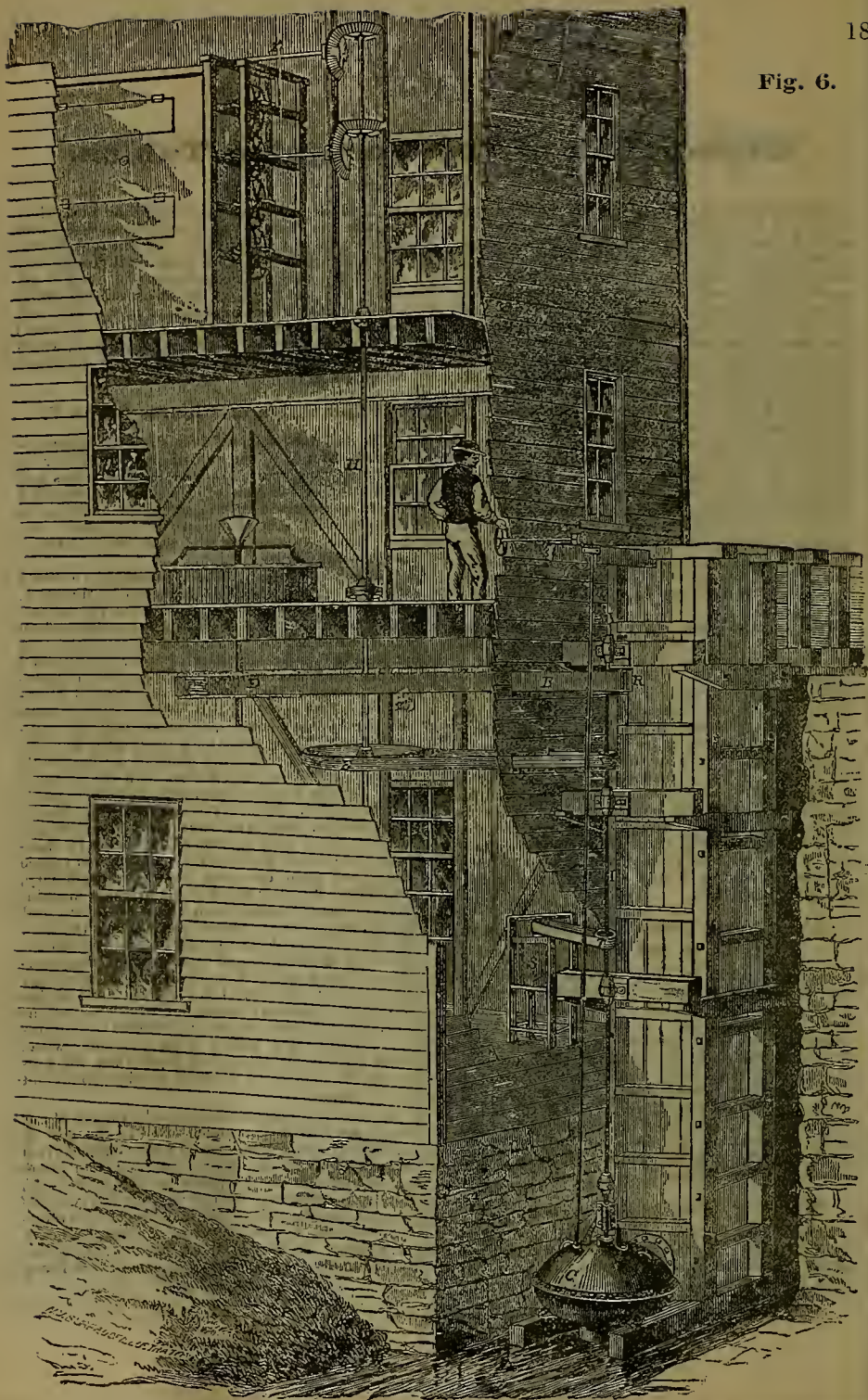
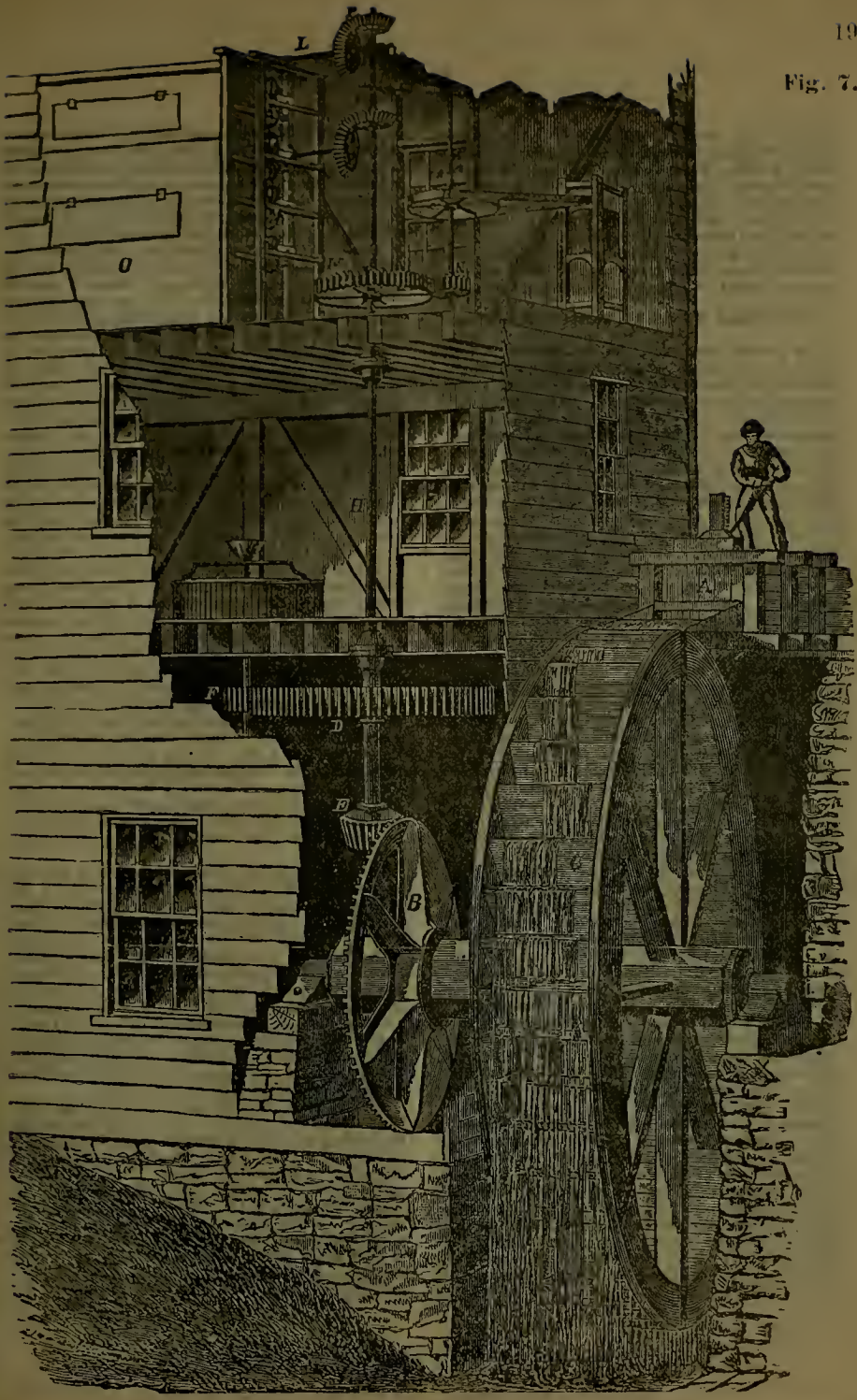


Fig. 7.



[*Continued from page* 17.]

gearing weighing thonsands of pounds, and constantly laboring nnder the disadvantages of a necessary increase of motion; while the whole amonnt of machinery required hy our wheel consists of only a short shaft and three pnlleys, altogether weighing hnt little more than one hundred pounds, and hesides haviug a motion of over five hundred revolutions per minute, shows the great advantages our wheel possesses over the overshot wheel.

Pcrcentage Tests of Water. Wheels.

The general introdnction of the Turhine Wheel as a motor was immediately followed hy attempts, with varying degrees of snccess, to devise some means of testing or measuring its power in the different forms in which it was coustructed. Up to the present time the method generally adopted has heen the use of the friction hrake, dynamometer, and the lifting of weights. While this method of testing a wheel appears a simple one, and should apparently yield definite results, it has heen found in the experience of manufactnrers of wheels and in that of practical mill-owners to he entirely unreliahle as an indicator of the amount of work the wheel will perform. We have held this view of the matter for years, in our pnhlications and correspondence. As an example of the position which we have taken upon this snhject, and still maintain, we make the following extract from our pamphlet issued in 1867:

"The ordinary method of determining the ratio of useful effect produced hy a wheel from a certain quantity of water is hy means of a friction hrake, or by raising weights, where the quantity of water aud the height through which it falls, or in other words, the amount of head and fall employed, is carefully compared with the amount of resistance overcome. Thus what is called the percentage of power is accurately obtained. Now, while, in a scientific sense, to ascertain the percentage of a wheel is of some value, and to which formerly mnch importance was attached, it has become a well-estahlished fact, from the many careful tests made by individnals and corporations, that the co-efficient of useful effect thus determined cannot he held as a measure of the efficiency of a wheel, or taken as any assnrance that the same comparative results will he ohtained, when applied to the various purposes of manufactnre. Before this fact was fully estahlished it was a matter of much astonishment not only to manufacturers, hut to the hnilders of wheels themselves, to find a great disparity existing hetween the results ohtained in an experimental test and the results produced when practically applied to propel machinery. So great has heen this difference that many wheels which, from the high per cent. ohtained hy test trials, gave flattering promise of a snccessful and economical wheel, when required to overcome the ever-changing resistance of machinery, have totally failed to meet the requirements of an economical wheel. So frequently have these failures occurred that it forms one of the great ohstacles in the way of introducing a really valuahle and successful wheel; and it is an ordinary thing for shrewd aud careful manufacturers to say: '*We know beautiful results can be produced before test committees, but what will your wheel do in my mill?*'"

It is a well-anthenticated fact that in an experimental test of the kind ahove described, a number of wheels widely differing in their actual practical efficiency may give an almost nniform percentage of power—the experience of manufacturers showing that of those very wheels some will do nearly donble the actual work performed hy others.

One of the most memorahle and instructive cases of this kind on record was the competitive test of water wheels at the Fairmount Water Works, in Philadelphia, in 1859–60. It is an unquestioned fact, and one within the knowledge of all mauufacturers of wheels, that in the Fairmount test, in which the lifting of weights was the criterion of effect, several wheels gave nearly 90 per cent. of power, while others were not far hehind; and that wheels which gave the most flattering percentage in the test were found in their suhsequent practical operation to he of comparatively little valne, while other wheels which stood relatively low in the experimental scale proved to he in practice far more effective than those which yielded the larger percentage. We cite the Fairmount test not only hecause it was a signal instance of the deceptive results of a trial hy percentage, hut also for the reason that the attention of mill-owners was largely drawn to it as one of the most exhaustive and searching tests ever uudertaken. That it was thoroughly and carefnlly condncted is shown hy the completeness of the preparatious. The apparatus for the test was constructed under a liheral appropriation hy the City Council of Philadelphia, and neither pains nor expense was spared. The amplest provision was made in money, material, and skill for the demands of the occasion, and manufacturers of turhines were invited to send or hring wheels to he tested, without extorting or impelling the payment of a fee. And in order to avoid any false compntatiou which might possihly occnr from the measurement of water hy the nse of a weir (which is liahle to erroneous results), an ahsolutely certain method was adopted, the water heing caught in a large tank and measured with perfect accuracy.

In the ascertaining of the usefnl effect or percentage the liahility to error involved in the use of the ordinary appliances was avoided hy suhstituting the lifting of weights, and in every particular the trial was beyond criticism in the minute precision with which its fundamental theory was applied. No one can qnestion the ability with which the test was conducted. It was snperintended hy the hest engineering talent in the country, and no candid man can read the admirahle and exhaustive report of the trial (which is contained in a large and handsomely illustrated pamphlet), without heing convinced of the thoronghness, skill, and impartiality which characterized it in every respect.

Yet, after all, of what practical value was this test? What did it teach? Simply nothing except the inadequacy of such tests to reveal those peculiar properties of the water wheel which constitute its value as a practical motor. The very wheel which gave the highest percentage of power at Fairmount, when put to the test of propelling machinery hy the manufacturing community, was fonnd inadeqnate and inefficient; and the maker of that wheel having at length abandoned it, after endeavoring for several years to pnt it on the market, adopted in its stead a wheel helonging to the

class which gave the lowest percentage in the Fairmount test, and is now engaged in its manufacture, with much better results than with the former wheel. Other wheels, moreover, which fell far behind in the Fairmount trial, have since attained a more eligible position in the estcem of the manufacturing community than the wheels which surpassed them in the experimental tests.

Aside from the inability of percentage testing to prove the actual worth of a wheel for driving various kinds of machinery, should it be done even in an honest and competent manner, it proves nothing whatever as to the durability of a wheel, or as to its general management when it has been once in operation a number of years. This requires the practical operation of a large number, many of which have been running for several years, before all the points of merit and demerit become apparent or fully demonstrated. So also is the case of repairing and the liability of breakage only subject to demonstration by actual use.

In view of the failure of all tests of the character above described, to indicate the actual available merits of the competing wheels, we are led to the unavoidable conclusion that the only reliable test of the power of a water-wheel is its practical working, whether in grinding grain or the propelling of machinery, under the varying conditions which it is destined to encounter, and for a length of time sufficient to exemplify those conditions and reveal their effect.

In the foregoing remarks we have had in view only these few tests which are at least honestly and fairly made, and about which there is no fraud, pretence, or intended deception. There is another class of "tests," so called, of which we frequently hear, but which might more justly be called conspiracies. We refer to the "tests" which builders of water-wheels in competition with the Leffel wheel often profess to have made, publishing the alleged results with an immense flourish of trumpets, and claiming, of course, to have achieved a brilliant victory over the Leffel wheel. The fact has, in almost every instance, proved to be that these parties had held a private test to suit their own ideas and interests, and entirely without our knowledge or consent. Sometimes we are informed from some distant part of the country, by some unknown builder of wheels, that he is about to make a test against our wheel in some mill, and that we must appear on the ground and see that our wheel is in order, which has perhaps been in operation a number of years. We are commanded by such novices as though we had nothing to occupy our time, or our business no claims upon our attention, and as though it were our duty to aid in making them and their wheel a reputation, or at least to give them influence by a recognition of their wheel. They, however, do not desire our presence; but it is done in such cases as reach our notice, for the sole purpose of a pretence to be fair, and to influence spectators or judges. Fairness and honesty is not what they want; it is their desire to test in our absence. It would be a very poor wheel which could not beat the Leffel under such circumstances, however much it might fall short of it in actual merit and practical value. The invariable selection of the Leffel wheel, however, as a standard of comparison by opposition wheel-builders, and their extreme anxiety to make it appear, by fair means or foul, that their wheel is equal or superior to the Leffel, is one of the most striking proofs which can be afforded that it is beyond dispute the best water-wheel in use.

New Reduced Price List of Leffel Wheels.

In conformity to the decline in values during the past few years, and in accordance with the wishes of our many friends and patrons, we have concluded to again make a large reduction in the price of our Water-Wheels, and herewith present a schedule of new prices, feeling that manufacturers, and others interested in water power, will appreciate to a just extent, a concession which makes the best wheel also the very cheapest.

We can rightly claim that our wheel is now, (when the size of wheel and power under any given head are considered,) furnished at a less price than any wheel of character now in the market. We have for several years been adding, by patents and otherwise, various improvements to our wheel, increasing its efficiency and durability: and in the past year have, for the smaller sizes, in some of the working parts, substituted more enduring and costly material adding to their cost; all of which, when combined with the liberal reduction now made, makes an abatement from former prices, such as we feel confident will meet the highest expectations and desiree of our patrons.

We shall spare no pains in future to construct our wheels in the most thorough and scientific manner, using the best of material so as to combine the greatest durability, with the most perfect principle and mode of operation ever possessed by a hydraulic motor.

For the first seven sizes, from 5¾ inches up to 15¼ inches, the wheels are made of polished brass: the first five sizes have also steel gates, consequently the price is higher in proportion to the other sizes, as it greatly increases the cost of manufacture. We also now use steel guides exclusively, instead of iron, for the wheels between 11½ and 23 inches diameter, without extra cost. When desired, we can furnish steel guides and brass wheels for any size, at a reasonable extra charge.

PRICE LIST

Leffel's Double Turbine Water-Wheel.

Size of Wheels.				Sq. inches Vent.	Price of Wheels.	Spherical Flumes.	Horizontal Flumes.
5¾	inchss,	Steel	Gates,	3¾	$200	$100	$150
6⅝	"	"	"	4 9-10	210	100	170
7⅛	"	"	"	6⅛	220	100	175
8¾	"	"	"	8¾	230	100	200
10	"	"	"	11¼	250	150	200
11½	"	"	"	14⅔	260	200	225
13¼	"	"	"	19¾	300	250	250
15¼	"	"	"	26¼	350	275	300
17⅛	"	"	"	34¾	275	300	350
20	"	"	"	45	300	350	400
23	"	Iron	"	59⅛	325	400	450
26¾	"	"	"	79	350	450	500
30⅝	"	"	"	104	400		
35	"	"	"	137	500		
40	"	"	"	180	700		
44	"	"	"	217	800		
48	"	"	"	259	1000		
52	"	"	"	338	1350		
56	"	"	"	441	1500		
61	"	"	"	518	1800		
66	"	"	"	624	2000		
74	"	"	"	769	3000		
84	"	"	"	991	4000		
96	"	"	"	1295	5000		
108	"	"	"	1800	6000		

According to Contract. According to Contract.

NOTICE.—The foregoing prices are for the Wheels in San Francisco. In ordering, don't fail to state which way the wheel must run: with or against the Sun.

Any inquiries concerning the Wheel, promptly answered.

N. B.—We never contract to deliver Wheels to any specified place.

Address, A. MYERS, - - - 825 Capp Street,

P. O. Box 2293, San Francisco, Cal.

MINERS' MEASUREMENT.

It is customary on this coast generally, to estimate water by what is popularly known as Miners' Measurement; which, according to custom, is any opening under six inches pressure. In some camps four inches pressure only is allowed, and in others ten. The pressure varies according to the circumstances of different camps; hence there is no correct standard upon which to base calculations. The pressure varying, varies the quantity of water of a given number of inches under the different heads; hence there is great difference in the judgment of miners as to what quantity of water constitutes a certain number of inches of water as it flows in a stream.

Taking these things all into consideration, no millwright or hydraulic engineer can come to any definite conclusion, from a declaration that this or that man, who proposes to construct a mill, has so many miners' inches of water. He may make his estimates for a six inch pressure, and it may be four, eight, or ten, or twelve; not knowing the pressure, the result would vary materially.

Again, the methods for constructing the openings vary, so that the quantity of water issued under the different methods, is as various as from the different heads. Therefore no definite calculation for mechanical purposes can be determined from miners' measurement.

The various results of miners' measurement range from 1.23 to 2.66 cubic feet per minute to a miners' inch, and sometimes as high as 3 cubic feet to an inch.

It will therefore be plainly seen by all, that the practice of this coast for estimating water is not practical, and ought to be abandoned.

The only definitely certain method is to compute the NUMBER OF CUBIC FEET per minute, which is accomplished by the following

RULE.—Get the spouting velocity of the water under the head, which is $\sqrt{b} \times 8.02$, multiplied by the number of square inches of the orifice, $\times 12 \times 60$, and divided by 1728, the number of square inches in a cubic foot, where b represents the height of fall in feet.

New Standard for Miners' Inches.

By this process any competent mechanic can determine what power may be reasonably expected from a given quantity of water under any given head. By this method all our tables are computed and our horse power, quantity of water and revolution determined.

We present to our many patrons of this issue a new method of computing miners' inches. We have frequently said before, and all persons dealing in water are becoming aware that the so-called miners' inch is no practical method of measuring water; nevertheless, we find many persons in distant parts of our country, who yet state in their letters that they have "so many miners' inches of water." For the information of all such we would append the following rules for estimating miner's inches in cubic feet. In this statement, the water must stand *above the middle* of the opening indicated:

3	inches	pressure,	1	miners'	inch,	= 1.16	cubic	feet.
4	"	"	1	"	"	= 1.22	"	"
5	"	"	1	"	"	= 1.37	"	"
6	"	"	1	"	"	= 1.50	"	"
7	"	"	1	"	"	= 1.62	"	"
8	"	"	1	"	"	= 1.73	"	"
9	"	"	1	"	"	= 1.84	"	"
10	"	"	1	"	"	= 1.94	"	"
11	"	"	1	"	"	= 2.03	"	"
12	"	"	1	"	"	= 2.12	"	"

In this estimate, the miners' inch is calculated, allowing the usual amount of friction. But a real miners' inch *ought to be* delivered through an orifice where all the inside edges of the orifice are beveled to a feather edge, and the feather edge is at the point of discharge. Every gate for discharging water by miners' measurement ought to be thus constructed.

When the number of miners' inches is large, the amount of water is largely in excess of this estimate, as the amount of friction on the sides of the orifice is so much less. We hope, therefore, all who address us will, in addition to stating their quantity of water in miners' inches, also say, "or, according to your tables, we have so many cubic feet under so many inches pressure, orifice or discharge made according to your directions." We will then be able to base our calculations of horse-power, &c., on reliable statements, and the performance of our wheels will come up to all expectations.

Old Method of Measurement of Water.

The method usually pursued to measure the water as it flows in the stream or flume, is to get the average depth and width in inches, and then ascertain how far a chip of wood, or any light substance of nearly the same specific gravity of the water, flows in a minute, in inches. These three quantities—depth, width and length—multiplied together and divided by 1728, will give the number of cubic feet as nearly as necessary for all practical purposes.

Other methods are used by practical hydraulic engineers, which are unnecessary to explain here. Where great accuracy is required, we will always go to the place and measure the water, for a moderate compensation and expenses.

VERY HIGH HEADS.

IMPORTANT INFORMATION.

The subject of Hydraulics has been very imperfectly understood on this coast, until within the past few years. Very few instances have occurred where water has been applied as a motor, where the head has exceeded forty or fifty feet, when the persons thus applying it have attempted anything like economy in its use in proportion to its due efficiency, to quantity and fall. Thus its application has been both rude and imperfect; and in no case have any adequate results been attained. In its application for hydraulic mining it has been equally unsatisfactory, until within the past few years, since when vast improvements have been made, which have mainly resulted from our suggestions. The evil heretofore has been in using *too small pipes*, to convey the water to the point of application; hence a large percentage of useful effect has been lost. Already several of the mines have adopted our plans, and are consequently deriving *more than double the useful effect of the water used.*

We saw this evil when we first went into the mining regions, and learned it most thoroughly by experience in erecting water-wheels for use under these high heads.

We soon saw that the useful effect derived by these wheels was not in proportion to the same quantity of water used under lower heads. The wheels did not make the revolutions due to the spouting velocity of the water under the head. Our next inquiry was to find out the cause of these discrepancies. Our first inquiry was, could it be in the wheel? We thought it might possibly be, as other eminent hydraulic engineers had declared that wheels for different heads must have the buckets so curved as to be adapted to the spouting velocity of the water under the head. We tried this suggestion, and conformed the curves of the buckets to the special requirements. A perceptible difference was discovered, but not sufficient to satisfy the discrepancies.

Our next inquiry was, was it in the water? Is there less efficiency in the use of water under high heads than low ones? Experiment has seemed to prove there was. It has generally been supposed, to be accounted for upon the theory of the decrease of the spouting velocity of the water, as the application is above a certain level, say 32 feet. But the application of the water for any head is based upon the spouting velocity of the water due to that head. Why, then, should the revolutions of the wheel be less? and the power derived from a certain quantity of water under the head be measurably less? Certainly every cubic foot of water weighs the same number of pounds, whether descending from a low or high fall, *provided it is not impeded in its descent.*

This, then, suggested the remedy. It was not altogether in the curves of the buckets—it was not in the want of efficiency in the use of water under high heads, but doubtless was in the manner of applying the water. We then set ourselves to experimenting, as well as theorizing, on the *manner of applying it.* The water doubtless did not yield the velocity due to its head, hence the want of equivalent revolutions and consequent loss of power. It must be the result of friction. The water coursing with such tremendous velocity along the sides of the pipes must cause great friction, hence loss of velocity, and loss of power—all of which was true.

Our experiments have extended over a period of fourteen years in this particular, and much money has been expended, as well as valuable time, and the results attained have been entirely satisfactory:

We now have wheels giving as good results under heads of 100 to 450 feet as any under the usually low heads. We have wheels in California and Nevada, working under 50, 75 and 110 feet, and up to 450 feet head, all giving unbounded satisfaction; to all of whom we can confidently refer.

During the last few years we have put up various sized wheels in various parts of Oregon, California and Nevada, under heads of 128 to 500 feet, to drive very large quartz mills. These wheels are put up upon new and improved principles. The water is conducted to the wheels through pipes 500 to 1000 and 3000 feet long, and down the brow of the mountains, the pipes conforming to the surface, thereby saving great expense in fluming. The pipes are attached to our new patent water-wheel cases, or Horizontal Flume. The wheels all give good results.

Two wheels—one a 13-inch reduced to a 10-inch, the other a 15-inch reduced to a 11½-inch—are in use under a 95-feet head at Ithica, New York, in the Cascadilla Mills, owned by H. C. Williams. This mill is represented on page 25, and has been in constant use for the last ten years. This same plan is used in all our quartz mills on this coast.

From what we have shown in the foregoing, it will be seen that our success, in adapting our wheels to *very high heads*, has been beyond all reasonable expectations.

From our past experiments, we have adopted the following arrangements to obtain the highest possible results:

The wheel to be encased in one of our patent Spherical Cases, and the water delivered to the wheel by an iron pipe which is capable of delivering twelve times the quantity of water that the wheel can use. For instance, the supply pipe for a 10-inch wheel issuing 11¼ inches of water, must be at its lower end at least 15 inches in diameter, and enlarging toward the top.

Our small wheels are all made to order and to be adapted to the head. They are all made with strength sufficient to stand the pressure required, hence the price of the same is to be by special contract, which will range from $250 to $800, according to conditions and material of which they are made.

We guarantee perfect satisfaction in the working of all our wheels when put up according to our directions, *whether under high or low heads.*

Fig. 8.

Fig. 9.

The Most Economical Method for High Heads.

Figures 8 and 9 show the most economical method for utilizing high heads. The usual method is, when a person wishes to build a mill of any description, first to obtain his fall ; then the quantity of water he can rely on, or the average quantity during the year. This should be measured in cubic feet. After having ascertained these things to his satisfaction, he next chooses the most eligible location for his mill. He now begins to erect his mill, and then the flume to convey the water to the mill. The mil wright having never been familiar with any but the old methods, advises a trestle work to carry the flume, and at an enormous expense of material, wages and time. He succeeds at last in getting the water to the mill. Then follows a season of leakage, when for a time nearly all the water escapes, until all the joints are swollen so as to contain the water. The most economic method is at once to discard the trestle work and flume, and convey the water to the mill with an iron pipe of appropriate diameter. This is by all means the cheapest, the most applicable and the most enduring. A trestle and flume, according to its height, generally costs from $5 to $20 per running foot in length; while the best iron pipes cost from $1 to $5 per lineal foot. These pipes are generally made at the shops in sections of 20 feet or more in length, well riveted, and coated inside and out with asphaltum, which secures them from rust. There is no leakage, and every available foot of fall is secured. These pipes can be laid along the surface of the hill, and anchored on rocks more easily than a trestle can be, and if in an exceedingly cold country, can be covered with earth to protect them from freezing. But as a general thing, if the water is kept running through the pipes, they never freeze up.

In nearly all the new mills, either for quartz or other mills, pipes are used now instead of the old trestle and flume. In all high falls, either a horizontal, iron or spherical penstock is used to encase the wheel, which is cheaper than the wooden one, and the pipe is easily attached with a suitable flange on the end.

There are quartz, flour and saw mills now using our wheels under 20 to 400 feet fall, applying this method with great satisfaction. The great point to be guarded is to have the pipe of sufficient size to convey the water to the wheel freely, without the loss of any of its power by friction along the sides of the pipes. If the pipe is too small a large amount of power will be lost in this way. Hence, upon this subject we ought always to be consulted before an order is given for the iron pipe. We might here give the usual dimensions, but the conditions being so various, to avoid all possibility of failure, consult us. The pipes are connected generally, with slip joints, thus making, when completed, one continuous pipe, but for better security on sidling ground and rocks, where the anchorage is not the best, occasional flanges should be used, as they make the pipe more firm over long stretches or declivities, but under these, the pipe should have occasional braces, as the pipe, when filled with water, carries great weight. By this method the great annoyance of breakage is overcome, and your mill is always dry and pleasant.

Wooden Penstock.

In this edition we give no cuts for wooden penstocks, except in the saw mill cut on page 33, as they generally now are discarded and iron used in their stead. If any of our customers choose to use them, every millwright knows the proper method of construction, and hence, need no instruction from us.

High Falls and Small Quantities of Water.

A PROPER TEST FOR TURBINE WATER WHEELS.

As the severest test a turbine wheel can be put to, is to take the place of an overshot wheel under very high falls. and with an extremely limited supply of water, such as is afforded by a few springs only, it certainly can be claimed for the wheel that will succeed under such circumstances, that it is the very best that can be constructed.

We therefore invite special attention to the statements we publish from our experience with overshot wheels, under high falls and small quantities of water—just the circumstances under which it has been formerly considered impossible for any turbine to successfully compete with an overshot; and we think it not too much to say, that the Leffel Wheel is the *only wheel* that can achieve these results under such conditions. But severe as is this test, the Leffel Wheel has not only proven equal but superior in every respect to the overshot; and it will also be observed that, notwithstanding the high degree of economy demanded in the use of so small a quantity of water, *not one of the wheels are using full-drawn gates. In fact, some are operating with gates only one-quarter open;* thus proving beyond a doubt the highest degree of economy in our wheel with partial gates.

Another fact that cannot escape attention, is the immense power produced by such small wheels. We claim this as a feature peculiar to the Leffel Wheel; and we have found by careful comparison with other wheels, that we can produce a far greater power from the same size wheel than any other wheel in use; thus enabling us to use a much smaller wheel for any purpose than can be used by any other form of wheel.

We built, some time since, a wheel of but ten inches in diameter, and using the same number of square inches and cubic feet of water that our 7¾ inch wheel uses; it supercedes a 120 horse power engine, as the wheel gives that power and has a head of 250 feet. It was built of fine brass and steel, with buckets made of German silver, and was a perfect model of strength and beauty. We have also put in operation several others recently, under heads of 80 feet and over.

The essential points to be observed are few and simple, and consist mainly in having the machin-

ery immediately connected to the wheel of neat proportions, and as light as is consistent with the work to be performed, and otherwise to reduce the friction to the smallest amount, as it must be obvious that massive machinery and much friction upon a small wheel running at a high velocity, must seriously detract from the good performance of the wheel. Simplicity in the arrangement of machinery is likewise of great importance, for it is a very easy matter to so absorb the power of small wheels by undue length of shafting and long trains of gearing, particularly *bevel* gearing, that there will be but comparatively little available power left.

Aside from a small wheel costing less, occupying a smaller space, lessening the cost of flume, etc., it is not necessary to mention that many advantages of using a wheel in which the greatest possible power is condensed in a small diameter, rather than to employ much larger and cumbersome wheels of other styles, which it would be necessary to employ in order to produce the same power.

Description of Plates on Pages 24 and 25.

The plates shown on pages 24 and 25 illustrate one of the most complete and successful achievements of hydraulic engineering in the country, and at once settles that, by use of the Leffel Wheel, many valuable powers can be created, where now it is considered impracticable by reason of the high fall and limited amount of water in the stream. The success of this will not only establish the fact that the Leffel Wheel is durable and gives a steady motion under excessively high falls, but, also, that so great is its economy in use of water, that a surprisingly large amount of power can be obtained from a very small stream of water. In fact, the amount of work done by the Leffel Wheel under these high falls, when compared with the small stream of water used, is surprising and a mystery to those who are not sufficiently acquainted with the principles governing the operation of the Wheel to know that the Wheel embraces in it the elements requisite to give the very largest amount of power that it is possible to obtain from a limited quantity of water. We, therefore, call particular attention to this mill, as it will no doubt convince others that they, by the use of the Leffel Wheel, may secure equally as valuable and as constant a power. The mill, as shown, is a large flouring mill, having five to six run of large burrs, and all the necessary machinery for a first-class merchant mill. On pages 24 and 25 will be found a description of the machinery as arranged in the mill. The mill is located at the base of a hill, from the summit of which the water is obtained to drive it. The stream is a very small one indeed, furnishing but a limited quantity of water. The water is carried down to the wheel, (which is located in basement of mill) through an iron pipe 500 feet long, where it is attached to a globe case in which the Wheel is placed. The wheel itself is 15¼ inches in diameter, but is reduced in capacity, so that it uses, with full gate, only the same amount of water as our 11½ inch Wheel, and can, therefore, virtually be regarded as one of that size. It is made wholly of brass and steel, and of the highest finish. The fall employed is 95 feet, and although the Wheel, with full gates uses only 14 square inches, yet it gives sufficient power to run six large burrs at one time, besides a vast amount of other machinery, such as separator, packer, etc. About two hundreed feet from the lower end of the main pipe is attached a branch pipe leading down to another mill (plaster mill) in which is placed a 13⅜ inch wheel, reduced in capacity to a ten inch Wheel; this Wheel operates under 82 feet fall, and is enclosed in globe case similar to the one in flour mill. The plaster mill is not shown in the plate.

After the water has operated upon the Wheel it is conducted through an underground tunnel and discharges through the small archway into the channel of a large stream, which will be seen flowing in front of the mill. The operation of this Wheel has excited the greatest interest and wonder throughout that vicinity.

The plate (fig. 9) page 25, gives the arrangement of the machinery in the mill shown on page 24 (fig. 8). Although the little wheel is doing an astonishing amount of work, yet the machinery which it drives is not arranged in as simple and complete a manner as the peculiar advantages of our wheel would permit, the mill having formerly been run by two large overshot wheels. In applying our Wheel, there was no change made in the machinery whatever; hence all the heavy, complicated machinery used by the overshot wheels, has to be carried by our little Wheel, which, added to the work of propelling five pairs of large burrs, makes its performance wonderful. We have taken some pains to show the manner of connecting this Wheel to the work, as it is a method that can be frequently adopted where it is desirable to connect our Wheel to the same machinery run by the overshot wheel, and where the machinery, for various reasons, cannot be changed. The burrs are located around the main spur wheel G, the shaft H extends up into the mill running the machinery; the pinion E, which receives the power of the Wheel through pulley D, works into the spur wheel G, thus driving all or any number of the burrs at one time. The belt, running from the pulley on the water wheel shaft, is 16 inches wide, and runs with a speed of almost 80 feet per second. B is the Globe case within which the wheel is placed, and although the pressure on this case is over 43 pounds per square inch, yet it remains perfectly water tight, and shows no signs of undue pressure upon it. A is the pipe which conducts the water to the wheel. At I, there is a screw or worm wheel, for opening the gates of the wheel, which by this means is done gradually, thus avoiding any sudden shock which might be produced by suddenly opening or closing the gates. The gates of the wheel, under this enormous pressure, are opened with the greatest ease, requiring in fact scarcely more force than if under a fall of only ten feet. The casing, B, is firmly bolted to timbers, secured by heavy masonry. In some instances it may be found convenient to use a short draft tube; but we aim always, where it is possible, to avoid entirely the use of any tube, except the short one cast in the Globe, the end of which should be so located as to touch the standing tail-water.

The Forebay Rack.

It is *highly important* that the rack across the race or forebay should he properly put in and attended to. The bars should he enough apart not to obstruct the flow of water, and should be kept clear of all trash; many inches of head are lost hy this neglect, and often the efficiency of a wheel is impaired hy the same cause. Proper attention given to this matter will pay well.

It is a good plan, and we would recommend it in all cases, to put in a coarse rack, eeveral feet above the rack just mentioned; the coarse rack will serve to retain the coarser drift, and thus avoid the necessity of frequent removal from the fine rack. The spaces of the coarse rack may be twice as large as the fine ones are. It is also advisable to cover the entire forebay with boards from the last rack towards the wheel and over it, especially where small wheels are nsed; such precaution will prevent rubbish from dropping or being thrown into the water and getting in the wheel.

Draft Tube.

In adapting wheels to very high falls, it sometimes becomes desirable, in order to avoid extreme length of shaft on wheel, and also to otherwise conform to the peculiar location of the mill, to place the wheel at a distance from tail-water and conduct the water away from the wheel by an *air-tight* tube called a Draft Tuhe. It is also desirable in some cases, when the ontlet is cramped, to employ a short draft tuhe, say two or three feet in length, thus bringing the lower timhers of the penetock up from the water, and allowing a free discharge; and likewise affording a greater convenience in getting at the wheel. There cannot be, ordinarily, any objection to the nse of a draft tube not to exceed ten feet in length, as within that limit, by good workmanship and proper material, a tube can he constructed hoth air-tight and durable; yet, as a want of experience in this matter might lead to mistakes, which would tend to greatly diminish the power of the wheel, we would here state that as a rule we would advise the wheel to be placed at the bottom of the fall. When the draft exceeds ten feet in length, and particularly when used for small wheels, it should be made of hoiler iron, gotten np in the most thorough manner, perfectly steam-tight, as onr experience has taught us that when the tube is of great length, a wooden tube can not be relied on as either water-tight or durahle.

End of Draft Tube.

The end of the draft tube shonld dip two or three inches helow the surface of standing tail-water. The same is necessary in making the wheel-pit, when a draft tube is nsed as when a wheel is put in without the tnhe.

Head Gates.

The head-gate is also an important feature of the arrangement necessary for utilizing the power afforded by a dam. Those of our reader- who are familiar with the suhject, are well aware that an nrgent need exists for a hetter plan of construction for head gates than the old lift-gate, which has a tronhlesome peculiarity of heing almost invariably out of order, just when it is most needed. The majority of head-gates are hoisted and exposed to the warping influence of the sun and weather, so that in a short time it requires much effort to shut one of them down; and in some instances they can not be got down at all.

A gate arranged similar to a butterfly valve, and entirely under water, tnrning horizontally by means of an upright or stem, could he constructed to good advantage. The stem or upright would serve as a pivot or hinge jnst above and helow the gate upon which it can turn or swing. It must not he in the precise center, which will admit of a little more pressure on one end than on the other, thus keeping it closed when not left or kept open. Another and somewhat similar method would be to let the pivots be at each end of the gate, and instead of swinging around horizontally as the other, it may turn down towards the inflowing water, laying entirely under water in a level or flat position. The stem or staff which is fastened to it instead of turning around, forming an axis as in the first case, ewings down in the direction of the gate and lies in the water also. In either case a forebay should be built of a greater length than width, planked up tightly on the sides and top, with trap doors in the top; the front and lower ends also closed hy planking down to as mnch as eix inches below low water mark. The gate may then he set about the middle of this flume or forebay in a etrong partition, which is really the separation between dam and race.

When the trap-doors are kept closed there is no danger of the water freezing, even in the coldest weather, it being entirely protected from exposure. As the gates are generally open and therefore, of course, under water, they are not exposed to warping hy the influence of the air and sun, hut when needed are sure to fit and to be easily handled and effective. Many instanceemight be given in which defective head-gates have been the cause of the washing ont and entire destruction to their being either frozen np or warped to such an extent as to be unmanageable, could not be closed in time, and as a conseqnence a small wash or break in the head-race, became the source of extensive damage, requiring a heavy outlay of money for its repair. It is easily seen in snch cases, after the catastrophe has occurred, that trne economy would have been consulted by providing in the first place a head-gate which could have heen easily reached and promptly closed, thus preventing any material injury. The teachings of such an experience are, of course, nseful in gniding the subsequent operations of the owner; but in this ae in many other matters, "an onnce of prevention is worth a pound of cure."

Fig. 10.

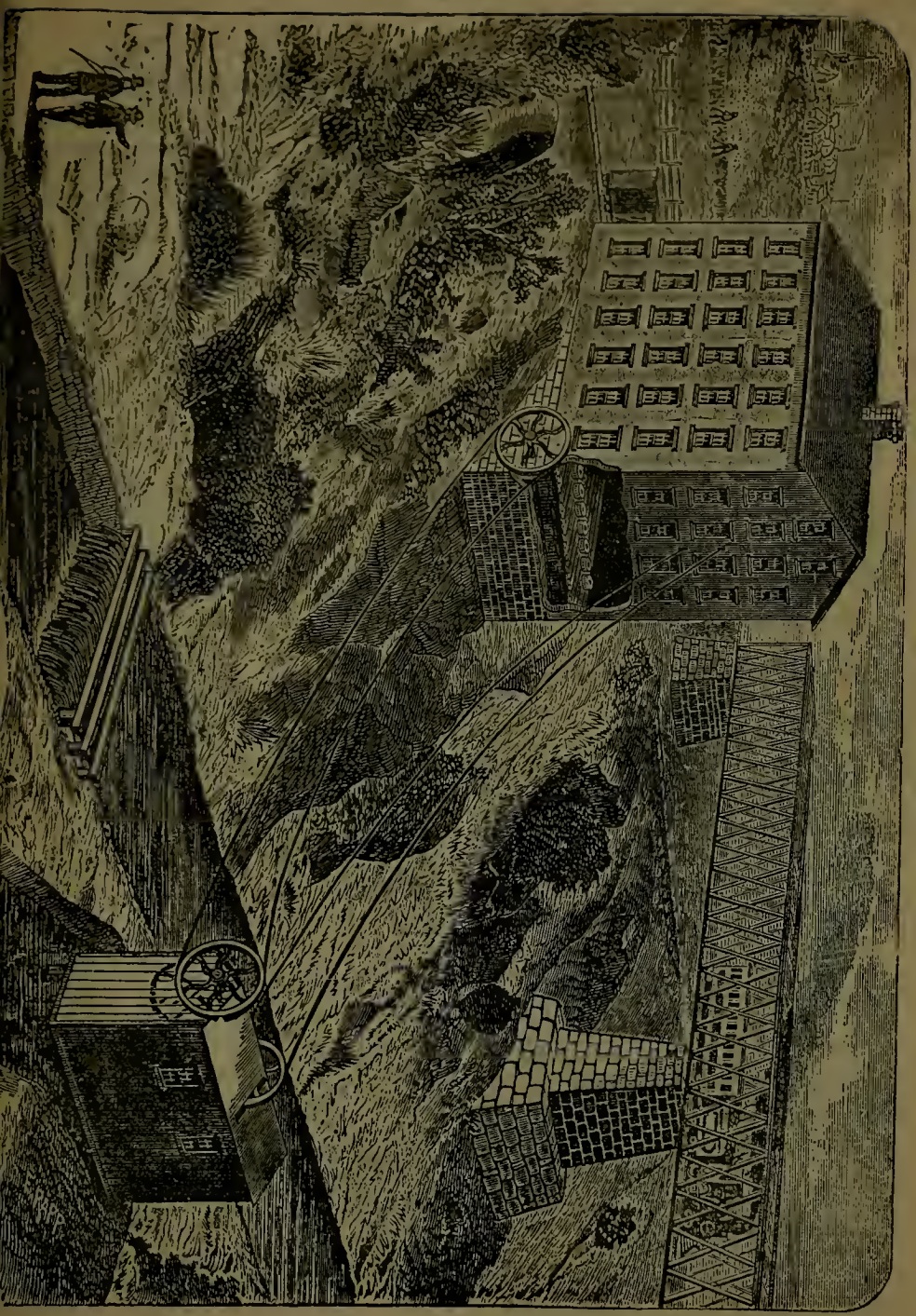


Table of Powers Transmitted by Wire Rope.

Diam. of Wheel in feet.	No. of Revolutions.	Number of Rope.	Diameter of Rope.	Horse Power.	Diam. of Wheel in feet.	No. of Revolutions.	Number of Rope.	Diameter of Rope.	Horse Power.
4	80	24	3/8	3.3	9	120	19	5/8	60.
4	100	24	3/8	4.1	9	140	19	5/8	70.
4	120	24	3/8	5.	10	80	19 18	5/8 11/16	55. 58.4
4	140	24	3/8	5.8	10	100	19 18	5/8 11/16	68.7 73.
5	80	23	7/16	6.9	10	120	19 18	5/8 11/16	82.5 87.6
5	100	23	7/16	8.6	10	140	18	11/16	96.2
5	120	23	7/16	10.3	11	80	19 18	5/8 11/16	64.9 75.5
5	140	23	7/16	12.1	11	100	18	11/16	81.
6	80	22	15/32	10.7	11	120	18	11/16	97.3
6	100	22	15/32	13.4	11	140	18	11/16	113.6
6	120	22	15/32	16.1	12	80	18 17	11/16 3/4	93.4 99.3
6	140	22	15/32	18.7	12	100	18 17	11/16 3/4	116.7 124.1
7	80	22	15/32	16.9	12	120	18 17	11/16 3/4	140.1 148.9
7	100	22	15/32	21.1	12	140	18 17	11/16 3/4	163.5 173.7
7	120	22	15/32	25.3	13	80	17	3/4	112.
7	140	22	15/32	29.6	13	100	17	3/4	140.
8	80	21	1/2	22.	13	120	17	3/4	168.
8	100	21	1/2	27 5	14	80	17 16	3/4 7/8	148. 141.
8	120	21	1/2	33.	14	100	17 16	3/4 7/8	185. 176.
8	140	21	1/2	38.5	14	120	17 16	3/4 7/8	222. 211.
9	80	20 19	17/32 5/8	40. 41.5	15	80	17 16	7/8	217.
9	100	20 19	17/32 5/8	50. 51.9	15 15	100 120	16 16	7/8 7/8	259. 300

Transmission of Power by Wire Rope.

SEE CUT ON PAGE 29.

Under many circumstances the location of prime movers is so difficult of access that convenience, at least, demands that the machinery be located at a considerable distance from the driving power, or in such relation to it that the customer, material, and manufactured product have easy access to and from the machine. It has been customary, until a recent date, to employ long lines of heavy shafting, pillow-blocks, coupling, etc., constructed and put into operation at a great expense, for the transmission of power under such circumstances; but a medium for transmission is now being introduced, and has been used to some extent with the most satisfactory results, which commends itself by cheapness and economy in maintaining it, and its perfect reliability while in operation. We allude to the system of *Wire Ropes*, passing over large sheaves or grooved pulleys with a very high velocity.

In Europe the new system has been extensively introduced, although its development in this country is comparatively trifling as yet; however, during the past few years considerable advance has been made towards its permanent introduction and application to powers for various purposes; and it may be regarded as a substantial and successful method of transmitting power. In a number of instances through New England, New York and other States, the power of the Leffel Turbine is being transmitted by this means; the most remarkable instances, perhaps, are those of Messrs. Smyser & Milton, at the Falls of the Ohio river, Indiana; the Warsaw Furniture Company, New York; Messrs. J. T. Stewart & Son, and Mr. Isaac Butts, of Rochester; New York; Berkey Bros. & Gay, Grand Rapids, Michigan; A. J. Cropsey & Co., Fairbury, Nebraska; and a number of others who could be named.

The plate on page 29 illustrates the case first mentioned—that of Messrs. Smyser & Milton—exhibiting the mill-house, ropes, wheel-house, race or canal, and sufficient of the surrounding scenery to convey correctly the idea of the entire arrangement. Two of our 84 inch wheels are employed under a head varying from six to nine feet, and are located in the wheel-house 200 feet from the mill-house; both of the wheels communicate their power to the mill-building by means of three-fourth inch wire ropes, and 14 feet drive pulleys, the rope having a velocity of about 5,400 feet per minute, or in round numbers a mile. One water wheel and rope drives seven run of burrs at full capacity, all of which are located in a line and driven by a single shaft, on which are placed bevel gears, the rope connection being made at one end of the shaft; the other wheel and rope drives the entire machinery connected with the mill, using only a small part of the power of the wheel; the attachment is made through the side of the mill fronting the wheel-house, and in the story above the burrs. The wheels take their water from the canal or head race, and discharge it in the river, but a short distance from the wheel-house.

The Warsaw Furniture Company transmit the entire power of our 23 inch wheel under a head of 57 feet (145 H. P.) by a seven-eighths inch rope, at a distance of some 200 feet. Messsr. Stewart & Son use a large part of the power of one of our 48 inch wheels under 29 feet head (227 H. P.) by this same means, but several ropes are employed; the balance of the power being transmitted by 500 feet of under ground shafting, which was used before the wire rope system was brought to their notice and introduced into the works. Mr. Butts has a 35 inch wheel under 16 feet head; the water-wheel being placed as usual, its shaft extends five feet above the surface of the water, on which is placed a bevel wheel working into one on a horizontal shaft, which carries an eight feet pulley, making 116 revolutions per minute; the rope ascending a tower perpendicularly 86 feet, at the top of which are two other pulleys for the ropes to pass over, and located in such position as to convey the rope and power in the direction desired; the rope passing across a canal basin, reaching another tower at the distance of 300 feet, passing over two five feet pulleys similar to those on the first tower, descending this tower and connecting with a pulley on the main line that drives the whole of a large manufacturing establishment. The rope, after performing its work, passes out of the second tower in the same manner as from the first, taking at the top another direction, at a distance of 250 feet, entering a third tower, which it descends, communicating power to the entire machinery of another large establishment; the operation in both cases being attended with the most perfect success in every particular.

Messrs. Berkey Bros. & Gay transmit the power of our 66 inch water wheel under six feet head across the Grand river, 750 feet, to drive their furniture factory. Wire ropes for transmitting power are manufactured of iron, steel, or copper, as desired, and always with a hemp centre or core to increase the pliability, their range in size being small, varying only from three-eighths to seven-eighths inches diameter for 3 to 300 horse power. For the smaller powers it is advisable to use a size full large to increase their wearing capacity; but it must be remembered that a large rope is stiffer than a small one, and that more power is lost in bending it around the pulleys. A seven-eighths rope having the same velocity as a three-fourths rope, transmits less power, simply because of its greater stiffness.

The pulleys should be made of cast iron, accurately balanced, with a stout hub and a deep flaring groove, the depth and width of groove depending much on the length of span, and whether or not the rope be subjected to side winds. The rope must run on a cushion of soft wood, oakum, rubber or leather; the last two mentioned are best, and are cut into pieces of proper shape to be driven into and fit at the bottom of the groove that has been so made as to prevent the filling from flying out. The rope runs on a cushion without any noise or slipping whatever, soon fitting a small round groove to itself, and is capable of running usually from two to five years, when a new rope can be supplied at trifling expense.

At the point where belting becomes too long, the wire rope is properly the transmitting medium, and may be employed even miles in length. When, however, the distance materially exceeds 360 or 400 feet, intermediate stations should be erected, mounted by double grooved wheels, by that means

dividing a long, continnons, and heavy rope into two or more short endless ropes, extending from one station to another. The station shonld be of nearly equal distance apart, bnt not so near one another as to prevent the proper tension of rope. Single pulleys are, however, now much nsed for the intermediate stations, and we believe to good advantage, there being hut oue endless rope in the whole distauce. Special care should be observed in getting the axles and journal-hoxes well adjusted, and in having a solid foundatiou reaching below frost, when tbe loss of power from friction of journal and air, with the hending of rope also, need uot exceed 12 per ceut, per mile, while the cost will fall below seven per cent. of tbe expense of shafting. Whenever the distance is less than 80 feet, it becomes ncoessary to stretch the rope very tight, as the sag cannot be depended upon for the required amount of tension; in such cases the rope should he one or two sizes larger, and the maximum velocity maintaiued. Should the distauce exceed 450 feet, with no opportunity for an intermediate station, the rope in this case should also be one size larger than would otherwise be required. In such cases it is also advisable to take up tbe slack or stretch at the end of two or three months; altbough the stretch is comparatively little, it is well to have them full tight at first, when after some ruuning, they will adjust themselves to tbe necessary tension. Wben it can be so arranged, it is advisable to bave the upper sido of rope the follower or slack side, and the lower rope tbe tigbt or pulling side. Obstructious may thus be often avoided, beside affording the rope more surface on the groove; but the upper rope should under no circumstances he allowed to become so slack as to swing upon the lower rope. The possihility of such occurrence would be increased hy the adoptiou of small wheels, hut should, with ordinary care and watching, give little or no difficulty. As to the size of grooved wheels, where there should a choice occur between a small wheel of high velocity, and a large one with a slower speed, the larger one should he preferred, since it botb furtber separates the rope aud diminishes the loss of power arising from the more ahrupt cnrvature of tbe small wheel. For size of pulleys, horse power transmitted, size and nnmber of rope, velocities of ropes, etc., yon will please examiue the tahle on page 30. We will at any time give auy further information desired upon tbe subject; aud can furnish grooved pulleys of the best style aud finish, from four to 16 feet diameter, and any size and length of rops that may be required, at the mauufacturers' prices.

SAW MILL—Explanation of Fig. 11.

Tbis cut illustrates a first-class circular saw mill, bnilt in recent and modern style, aud supplied with all the arrangements and conveuiences for manufactnring a large amount of lumber; although tbe minor details are omitted in the illustratiou, that the circular mill, penstock and connection of the wheel, saw and work, may be exexhibited on a scale of sufficient size, without complications, to render the general plan casily understood. The water wheel in this case may be our 30½ or 35 inch, nnder a 14 or 15 feet head of water, and located as the design represents, in a decked penstock.

It is by no means essential that the decked penstock in all cases should be used for saw mills; it usually happens, however, where the head is more than an average height, it becomes necessary, for the sake of conveuience, that tbe power he taken off helow the level of head water, in which case the decked penstock is required, or a hetter snbstitute is having an iron casiug as illnstrated on page 8.

Tbe horizontal flume is by all means better adapted to saw mills and other factories, as it entirely does away with the hevel gear, and tbe connection is made by belt from tho pnlley on the water-wheel shaft to a pnlley of proper size on the line shaft.

This cut represents also the metbod of constructing decked flumes for low heads wbere the power is to be carried under the mill below the head of water. Great care ought to be taken in tbe discharge, that it is free and clear of obstructions, and as represented in Fig. 2, page 5.

The arrangement of saws in this cut is very imperfect. The saws should hoth turn the reverse way in order to throw the saw dust out of the curf. Spaulding's inserted teeth are the hest. All inquiries of us on proper arraugement of saw mills, will he immediately answered. The saw mill machiuery manufactured in this city is beyond doubt the best made anywhere.

Parties Ordering Wheels

Will please state wbich way they should rnn—with or agaiust the sun, as we make tbem to run either way, according to order; and write your shippiug directious iu a clear manner.

Parties wishing any further information concerning the wheel, not contaiued iu this pamphlet, or having any particular location to wbich they wisb to adapt the wheel, will please write us, and we will take great pleasure in answering any letters. In writing to us. we wisb parties to state plainly their post-office address, aud particularly to name the *State.*

Warranty.

Our wheels are warranted to work to entire satisfaction, wheu they are put np in perfect accordance with our instructions in this pamphlet, wben speeded under the head, accordiug to the number of revolutions designated in the tables, and using tbe quantity of water described. When thns pnt up, if they do uot perform for the eutire satisfaction of the purchaser, they may be returned iu six months, we paying the freight, and money refunded. *Any variation from our directions vitiates the guarantee in every particular.*

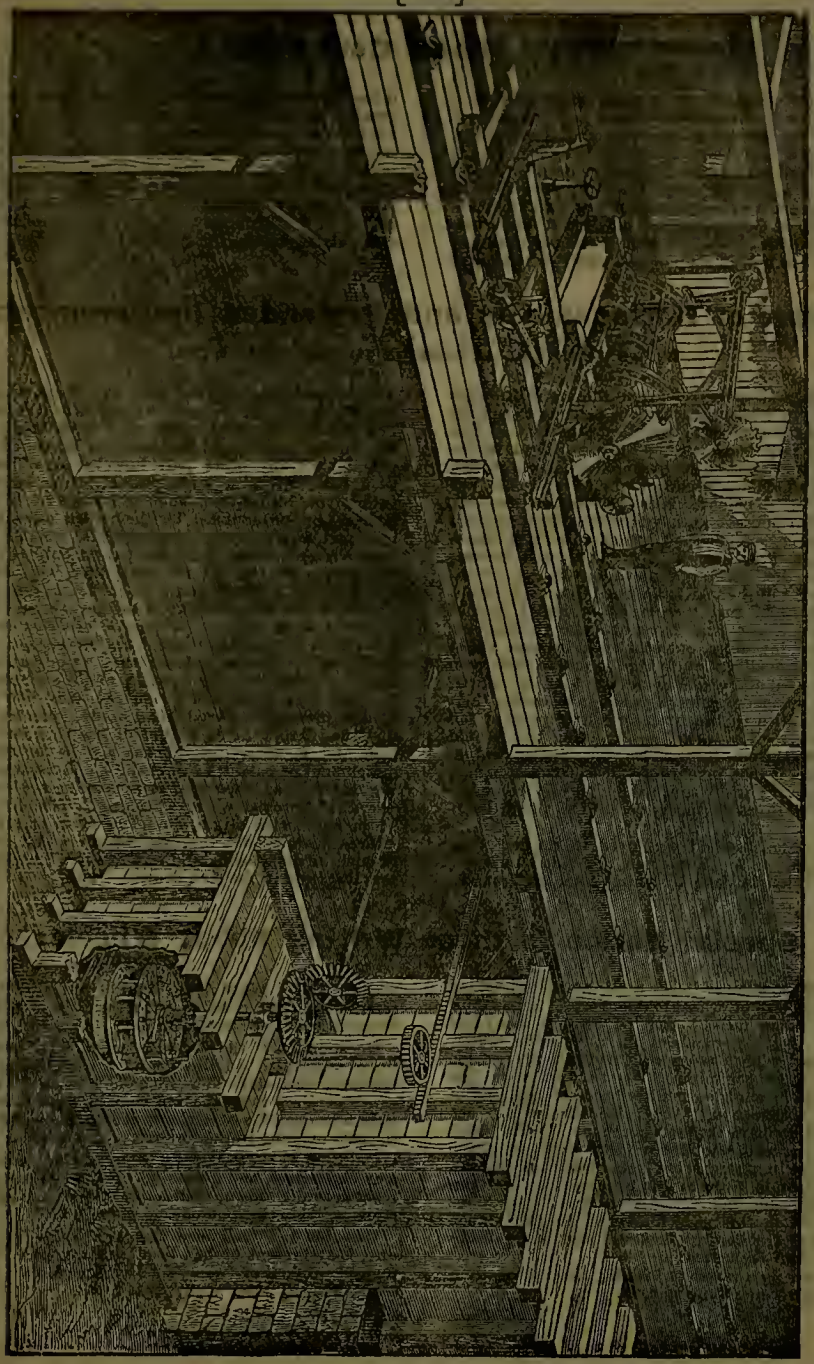


Fig. 11.

Water Wheel Governors.

We are preparsd to furnisb, at short notice, Governors of the most improved patterns for regulating onr wheels, at the manufacturers' prices. Our large experience in the introduction of the Leffel Turbine, and its application to all sorts of purposes, especially where the work to be done is intermittent and irregular, together with the manufacture of Governors, has afforded ns opportunity to acqnaint ourselves with the varions machines in that line now in the market. At the same time it has been our object also to obtain those of the greatest efficienoy, and from which the best results might be expected, as freqnently they afford aid to the successful operation of the wheels. We will take pleasure at any time in offering any advice when called npon as to their attacbment to Turbines, and as to styles that may in differeut cases prove most satisfactory, whether the purchase is made of us or not.

Beware of Infringements and Pretended Improvements.

WE ASK CAREFUL ATTENTION TO THE FOLLOWING:

We deem it necessary, from the many attempts now being made to evade our patents, to call the especial attention of the publio to the fact, so that no one may become innocently involved in the tronble that must ensne hy purchase of wheels and casings which are in part or wholly covered by onr several letters patent. It is well known that ALL GOOD AND SUCCSSSFUL INVENTIONS ABE INFRINGED UPON; for as soon as the long aud nnwearied efforts of an inventor have been crowned with snccess, (despite the world of opposition be has to encounter), and the merits and ntility of his invention are established, there at once arises a host of imitators—those who have not the patieuce or genius of inventors, but who seek by some slight change or modification to appropriate to their own use the vital and essential points of an iuvention, hoping by a mere colorable chauge to escape their just liabilities to the inventor whose years of toil first gave to the world the inveution they wonld fain wrest from him. This, the reader will at once see, is not invention—IT IS MERE PIRACY—and deserves to be spurned by all who recognize in a true inventor tbe greatest of all public benefactors.

The nsual metbod employed to impose npon customers is, to offer some preteuded improvement, which is done by taking some well known machine and attaching to it some small part, which, however small, if it be new, is subject to a patent. For instanoe, a water wheel may have thirty to fifty of its parts and combinations protected by patents; yet any other part, however small, snch as a bolt, nnt, arm, lever, pinion, strap, stirrup, gate, pivot, bridge-tree, bncket, husb, etc., if attached, and prononnced by the patent officials a new and novel device, is patentahle, whether an improvement or not; but snch patent ouly covers the particnlar part in its connection with some other, and of course does not in the least grant any right or privilege to nse any of the parts previously patented; such right to the nse of other patented parts must be obtained throngh the full consent of, and from the parties holding such prior patents. But this is too often disregarded, and the rights of previous inventors totally ignored; this new inventor, presuming through ignorance, bigotry or dishonesty, that he is master of the entire situation, and however insignificant may be his little attachment or patent, is publishing aud representing that he has discovered or invented an entirely new and improved water wheel; such falsification of the facts is the origin, sooner or later, of prosecutions against both tbe manufacturers and nsers of snch infringements, and a sonrce of almost endless litigation in the civil courts.

Special Notice to those Writing about Wheels.

We are constantly in the receipt of letters asking about the size of wheel to do a certain amount of work. Some merely say, "I have so many feet head"—not a word abont the qnantity of water. Some say, "The stream will fnrnish so many cnbic feet of water per minute"—not a word abont the head; and some give neither head nor quantity of water. Others ask, "What size wheel shall I nse to grind so many bnshels per hour?" This may appear strange, but it is a fact; hence we are so particular in stating what is required to be kuown. If attention is given to this article as to ascertaining supply and quantity of water, and the questions contained on this page answered carefully, mncb time and trouble will be saved and many disappointments prsvented.

In orderig a wheel or asking for information, please give the following data:

Question 1. What is the bead of water wheu at rest; or the vertical distance from surface of head-water to surface of tail-water?

Question 2. If the stream is small, what quantity of water can be relied npon; or if an overshot has been used, state how wide and how much the gate was raised to let the water on it, and particularly how deep the water was above the center of the gate opening in tbe forebay.

Question 3. If the stream is large, state wbether a creek or river, and if possible give ns a measurement according to our instructions for "large open streams," described on bottom of page 22.

Question 4. What size and kind of wheel, if any, is at present or bas been running, and bow many hours out of twenty-four will the stream afford sufficient water to snpply it?

Question 5. What kind of machinery do you wish to run? stating all the particulars you can.

Question 6. If a corn or wheat mill, state whether an old or new mill, size and number of burs, how many bushels each one is grinding at present, and how much you wish to grind on each; state how many are to be running at one time, whether one, two, three, or more.

Question 7. If a circular saw, state particularly the size, and what speed it has if an old mill, or what speed desired if a new mill, and particularly what kind of timber is to be sawed and the amount per day.

Question 8. If a sash or vertical saw, state speed or number of strokes it makes or is desired to make, and the length of stroke, what kind of timber you intend cutting, and particularly what amount of feet, inch measure, you intend cutting in twelve hours.

Question 9. If a woolen mill, give the number of sets of machinery, whether light or heavy, and kind of goods made; state whether new or old mill, kind and size of wheel in use.

Question 10. If a quartz mill, how many stamps and of what weight each. Number of pans, settlers and amalgamators, and of whose make; also, whether a silver or gold mill.

THE DOUBLE WHEEL.

We wish here to make a few explanations in regard to the feature in our wheel we characterize as a Double Wheel, as many have been led to erroneously believe it is in its compound form similar to many other double wheels, in which the water discharged from one set of buckets is made to operate on a second set, with the idea of more effectually securing a maximum effect of the water. It is not our object to discuss or point out the obvious objections to the arrangement of this double form of wheel, as it is now universally considered to be essentially wrong in principle. But our object is to explain the construction of our wheel sufficiently to prevent its being confounded with the class of wheels mentioned. In our wheel there is a combination of two independent sets of buckets—one having a center and the other a vertical discharge, and each receiving independent of the other, its proper quantity of water from the same guides. As one set of buckets is placed immediately under the other, a combination is thus effected without increasing the diameter of the wheel. By this arrangement there is admitted the greatest possible volume of water to a wheel of any given size, and at the same time securing the greatest area for escape of water—thus reducing the surface of the wheel, as compared to the quantity of water used, to the smallest amount, thereby avoiding a great loss by friction, an element which serves to diminish much of the effective power of a wheel.

To those understanding the necessity of reducing the frictional surface in a wheel to a minimum, the value of this arrangement is apparent, and the results obtained will fully justify us in attaching to it the importance we do.

Construction and Finish of our Wheel.

We make the manufacture of our wheel a specialty—our works, and particularly our machinery, being specially designed for that purpose, and all other work done being merely incidental to it. Most of the turbine wheel manufacturers carry on a large machinery business, to which it is utterly impossible for them to pay the attention necessary to the construction and finish of water wheels, and their adaptation as a hydraulic motor.

We pay special attention to the construction and finish of our wheel. The guides or gates, buckets, etc., are ground smooth. Every part of the wheel and casing over which the water flows is turned to a smooth surface, so that the water flows through the wheel with as little friction as possible; and all wheels under 15¼ inches are made of brass and steel, polished to a smooth, even surface.

We have discarded the use of iron guides in the 15¼ inch wheel, and now make them exclusively of steel. By so doing, we are enabled to give the wheel a better finish, and the guides remain free from rust or corrosion. Many parties prefer brass guides even for the larger sized wheels; and we furnish many specially ordered in this way, and are prepared to furnish brass guides, or an entire brass wheel, of any size we now make of iron.

Our wheels are put together in the most accurate and substantial manner by thorough machinists, and not thrown together as a great many cheap and worthless wheels are. It has been our utmost endeavor to make a first-class wheel in point of finish and workmanship. Our patterns are made entirely of iron and are as perfect as skilled workmanship can make them.

The Step or Pivot.

Our wheel is so arranged mechanically that the head and fall of water produces no weight whatever upon the step or pivot, the action of the water tending rather to lift the wheel, thus preventing to a great degree the wearing down of the step, and also the waste of power from friction. We have wheels running now that were put in when the wheel was first invented—running on the same steps as when first put in. If in the course of years the step should wear down, it is only a matter of a half hour to take the bride-tree out and put in a new step. We have always on hand *robenia* wood, from which we make our steps and followers, the best in the world, and can furnish steps, on short notice, of any size.

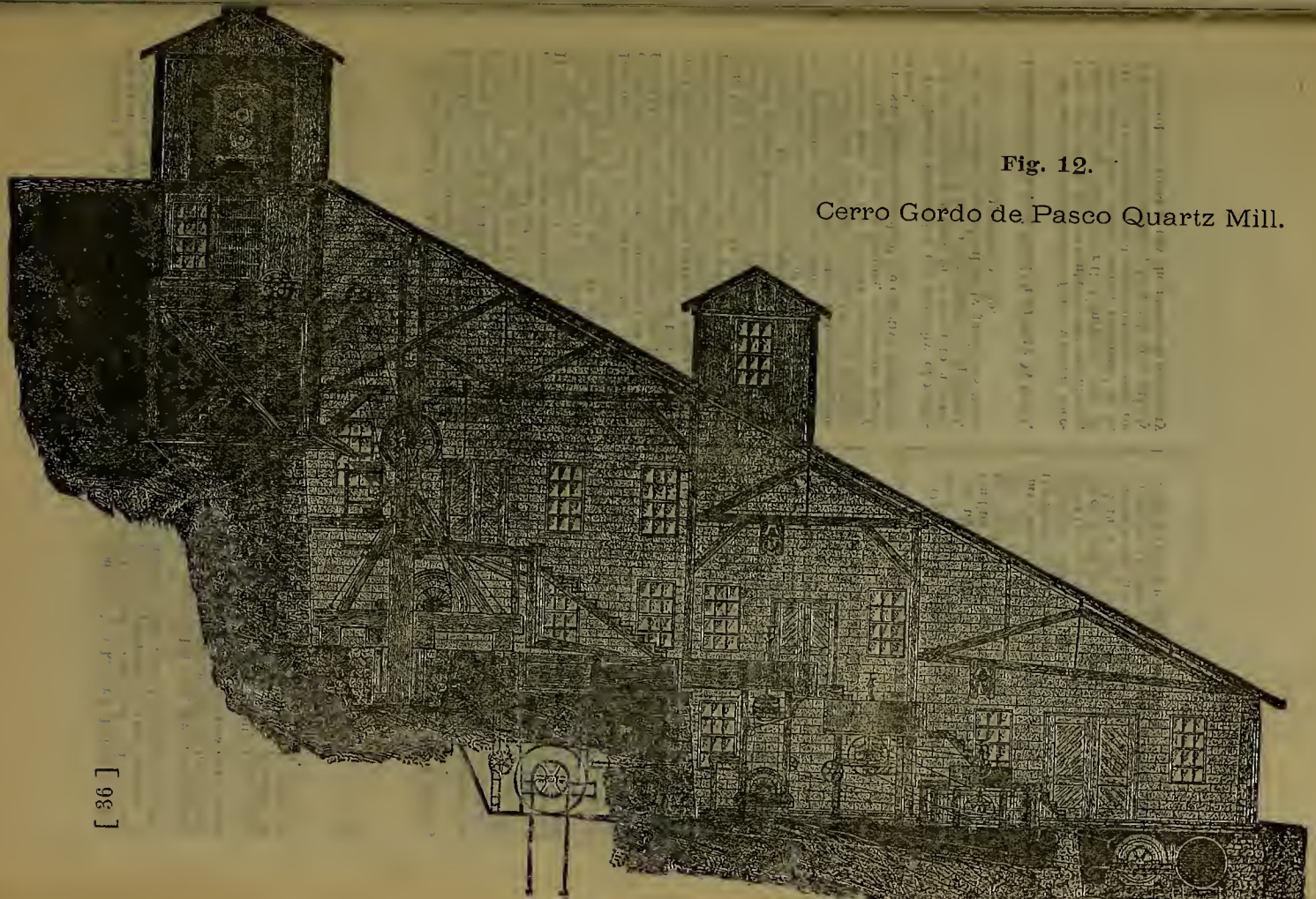


Fig. 12.

Cerro Gordo de Pasco Quartz Mill.

Explanation of Figs. 12, 13 and 14.

In figure 12 we have presented a beautiful illustration of an 80-stamp quartz mill, of the latest and best style now manufactured. The drawings from which this figure was taken were made, as well as the mill, by the Pacific Iron Works of this city. The mill was made for the Cerro Gordo de Pasco mines, in Peru, and had to be made in sections not weighing more than 300 pounds each, as the whole mill had to be packed into the mines on the backs of mules. This beautiful and wonderful mill is driven by six Leffel Water Wheels, on horizontal shafts—four 30-inch and two 23-inch. The head employed is 47 feet, and as the head is above that used in our tables for these sized wheels, the estimates of power, revolutions and water used, had to be specially calculated for this mill.

This engineering proposition was placed in my hands, and all the motions of the various parts of the mill were based upon my calculations. Each 30-inch wheel develops about 200 horse power, and each 23-inch wheel about 100 horse power, making about 1000 horse power employed in the mill.

Figure 14 shows the internal working and arrangement of the mill, and the method by which the power of the water wheels is applied.

Each 23-inch wheel drives 40 stamps, and each 30-inch wheel drives a separate set of pans, settlers, amalgamators and concentrators, for 20 stamps. Thus all the different parts of the mill are driven by separate wheels. The mill was built here in this city, and boxed for each mule load, and shipped to Peru, where it is now being erected on one of the oldest and richest mines in the world. The engineer, Mr. William H. Cilley, examined all the factories for making quartz mills, and the methods of propelling them, and after the exercise of great care and excellent judgment, decided that the mills manufactured in San Francisco were the best in the world, and the Leffel Water Wheel on a horizontal shaft, was the best and most reliable power that could be found any where. Three of these wheels are supplied by one large iron pipe, and the other three by a similar one, which is extended along the surface of the ground to the head of the fall.

In figure 14 we give a bird's-eye view of only one-half of the mill, the other half being a complete duplicate of the one here represented.

The finest and most complete quartz mills found any where in the world are manufactured here in San Francisco. The great energy of our skilled mining engineers has been taxed to the utmost to overcome the many obstacles presented in reducing the various kinds of refractory ores found here, and in every case they have been successful; and our engineers, with their excellent machinery and peculiar devices, have been found equal to any emergency.

All any person has to do, who finds difficulty in accomplishing any purpose, is to let it be known to the proper persons here, and their most difficult problems are immediately solved.

We take pleasure in saying to any one, if you have any difficulty in reference to any hydraulic arrangements about your water power, or of its application or adaptation, we will take pleasure in solving the problem. From our experience of nearly twenty years in hydraulic engineering, we ought to have obtained some celebrity.

Figure 13 represents the manner of bringing the water from a high elevation, through iron pipes laid along the surface of the ground, to a quartz mill.

The Phœnix Quartz Mill, at Plymouth, Amador county, Cal., has a 26-inch pipe 700 feet long, leading from a low bulkhead or penstock to one of our horizontal wheels, under 67 feet head, using only 250 cubic feet of water per minute, and driving forty stamps and all the machinery of a gold mill. This wheel has been in operation over five years, and is giving good satisfaction yet.

These iron pipes need not necessarily be made here in this city. They can be punched and rolled here and packed in bales, and put together at the mines or mill site, thus saving heavy freight bills in transportation. A few skilled mechanics can put together a long line of pipe in a few days, and asphaltum can be applied when completed. We estimate cost of pipes on application, and furnish them of any size by contract on shortest notice.

We also estimate the cost and construction, and contract for, any and every kind of mills. We furnish any and all mill gearing on short notice.

Virginia City, Nevada, February 15, 1873.

Messrs. Leffel & Myers:

Gents—We have in our three Quartz Mills, Santiago, Franklin and Eureka, all on the Carson river, your Double Turbine Water Wheels. The first (Santiago Mill) was supplied with the Leffel wheel about two years ago, and displaced a Jonval. This mill has been in constant operation, and *no* delays whatever of any kind have occurred from any defect of the wheel; with a head of 18 feet it is driving 30 stamps and crushing 75 tons per day.

The Eureka Mill is a new mill, built and adapted to your 52-inch wheel placed horizontally. The head is 36 feet; we have 8,000 cubic feet of water per minute, the wheel yields over 400 horse power, and has run constantly since first started, giving us no trouble whatever, and at all times perfectly at our command. The Eureka mill has 60 Stamps, 26 Pans, 15 Settlers, 8 Amalgamators, and all necessary machinery, all of which is driven by this one wheel, besides elevating the ore a distance of 50 feet high, on an incline of one foot to the rod, and driving the pumps for supplying the mill with water. The wheel at several times has broken 5 and 6 inch shafts, driving different parts of the mill, but no serious trouble has been experienced from that cause, as the velocity of the wheel is so near its maximum, that an instant demand or relief of power does not seriously affect the revolutions of the wheel. This mill crushes from 180 to 200 tons of rock per day.

We consider your wheels far superior to any other wheels in use, and we have had much experience in the use of overshot wheels as well as various kinds of Jonval Turbines. Taking everything together, there is no superior to Leffel's Double Turbine, and we cheerfully recommend them to all using Water Power.

In the Franklin Mill, we use one of your 56-inch wheels, driving 30 Stamps, under 15 feet fall, crushing 60 tons of rock per day, the wheel operates equally well in all the different mills. We are, Yours, respectfully,

A. M. EDGINGTON, Gen. Supt. Union Mill Co.
D. C. MACKEY, Superintendent Santiago Mill.
W. R. KING, Superintendent Eureka Mill.

Fig. 13.

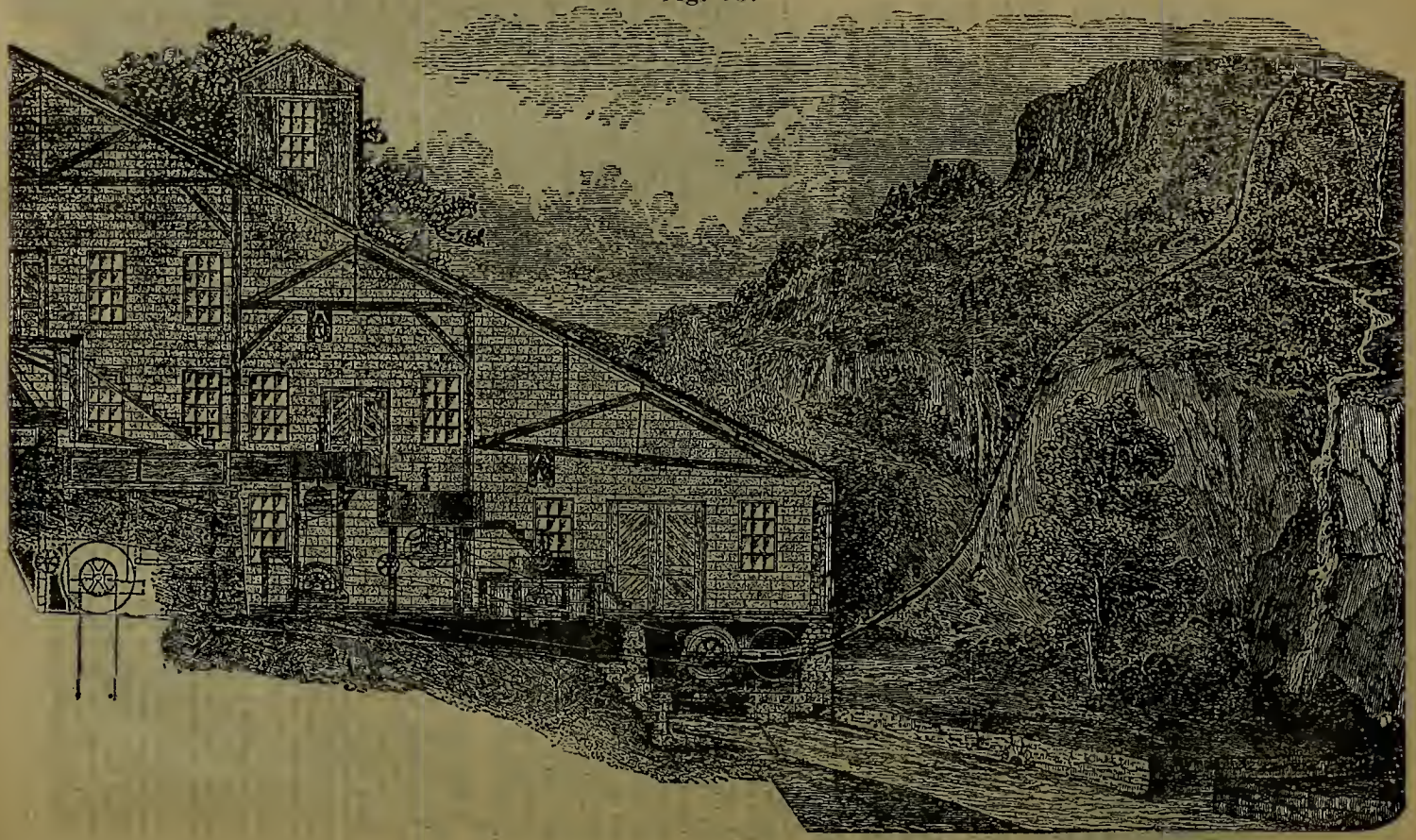
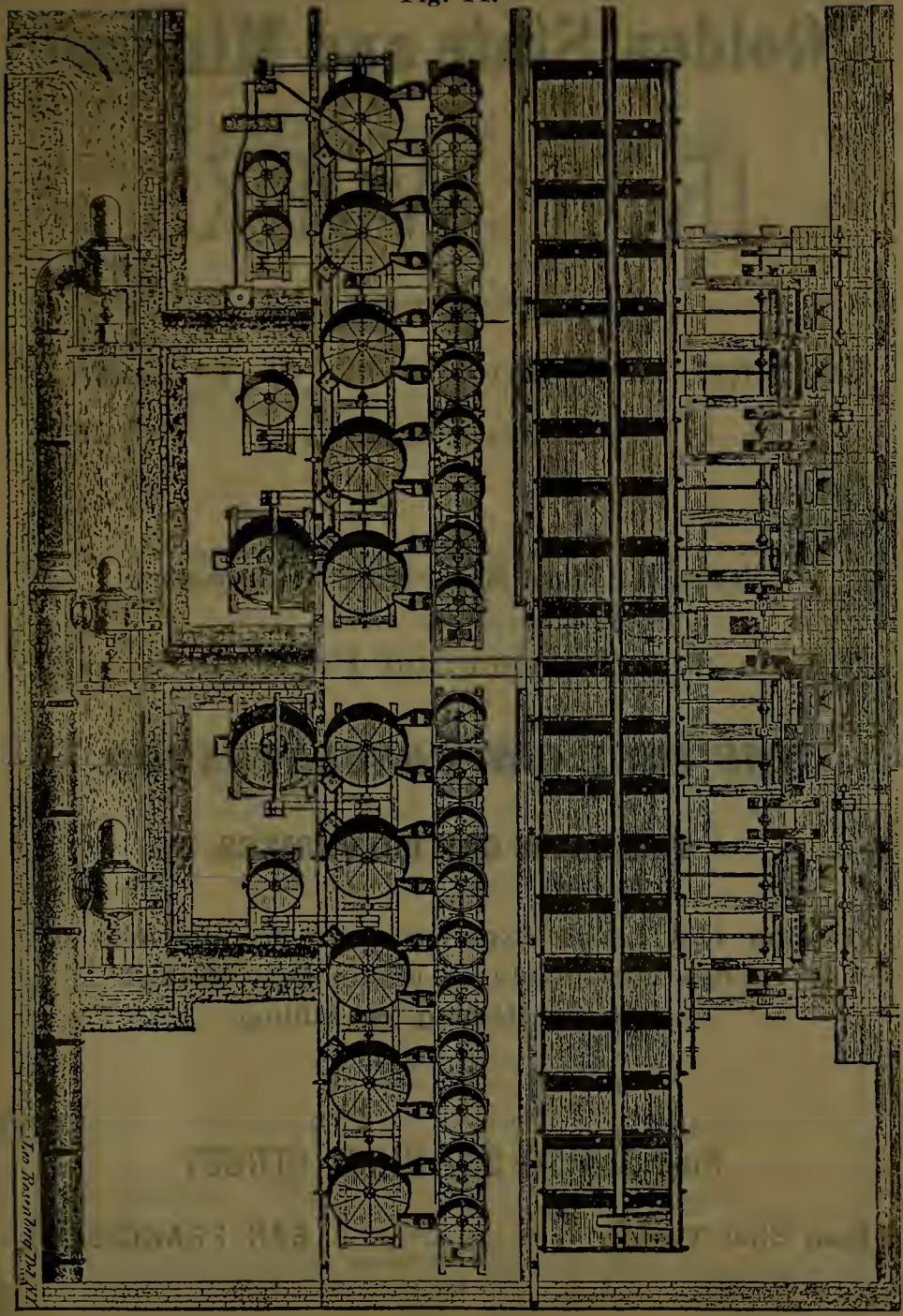


Fig. 14.



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